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Vol. II No. 2

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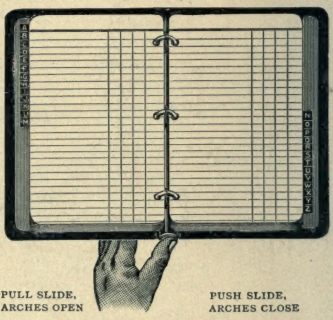

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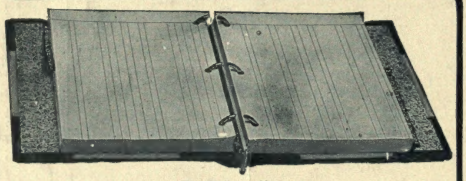

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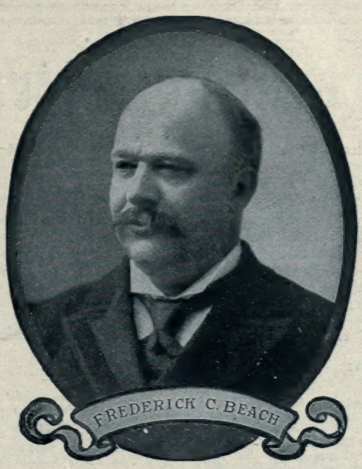

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Read through this number, and if any suggestions occur to you for the betterment of the magazine let us hear from you.

The Editors.

THE TECHNICAL WORLD

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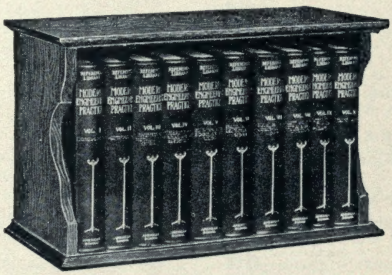

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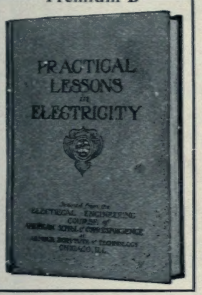

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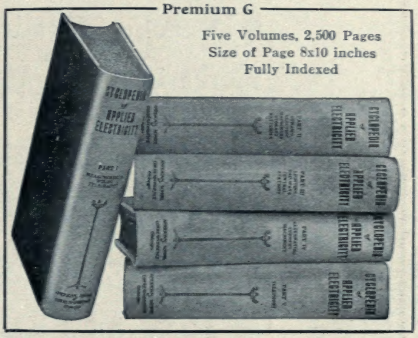

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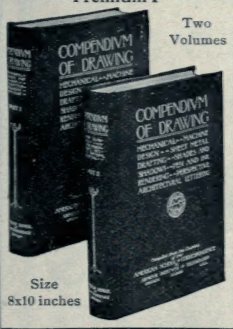

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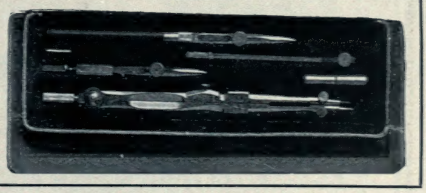

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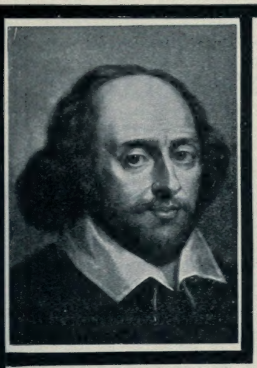

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The New American Forestry

Function of the Forests in Insuring and Regulating a Permanent Water Supply—The Urgent Need of National Action for Their Preservation

By GUY E. MITCHELL

CONTRARY to the oft-repeated statement that during the first century of the United States the only thought with regard to the vast forest cover was to lay into it the axe and the saw, the early sentiment for forest protection was strong. It has been in comparatively recent years that the United States has become a spend-thrift—is wasting to-day—one of the greatest natural resources of any country on earth.

In the early days, Massachusetts made repeated enactments looking to the care and protection of the forests adjacent to the various communities; and New Jersey laws against forest fires are old enactments upon the statute books. In Pennsylvania, the founder of the commonwealth made it a condition, that, of all land acquired from him, one acre of forest should be left standing for every five acres cleared. The sentiment favoring forest protection was universal in the States, as viewed by our present standards, though the early settlers thought that in the very conservative cutting and clearing which they did they were vastly extravagant. They came from a country where wood was scarce, and where respect for the forests had been bred through generations of their ancestors. It has been during comparatively recent years, bringing with them new uses for wood, accompanied with the belief that our forest resources were illimitable, that there has gone forward the wholesale destruction which, if continued at but the present rate, will sweep away every acre of American timber land during the next generation.

Revival of Forestry Sentiment

The pendulum of extravagance, however, is swinging backward, and the nation is beginning to see again the value of its forest asset. Already fifty-three Forest Reserves have been created by presidential proclamation, including some 60,000,000 acres; and "withdrawals" are constantly being made by the Interior Department, preliminary to the creation of additional reserves dependent upon the approval of the National Bureau of Forestry.

The largest of the forest reserves, including the national parks, is the Yellowstone—that Nature's wonderland, with its 7,800,000 acres. The following table shows the forest reservations made in the Western States and Territories:

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Extent of Forest Reserves

Arizona	6,700,000 acres.
California	8,800,000 acres.
Colorado	2,900,000 acres.
Idaho	4,000,000 acres.
Montana	7,900,000 acres.
Nebraska	208,000 acres.
New Mexico	3,200,000 acres.
Oregon	4,600,000 acres.
South Dakota	1,200,000 acres.
Utah	2,700,000 acres.
Washington	7,000,000 acres.
Wyoming	8,200,000 acres.

It was not until the last decade that the alarm over the rapid passing of the American forest began to take definite form and demand some check. In 1896 the existence of 18,000,000 acres of forest reserves, wholly without care by the Government, the timber from which was being stolen right and left, led the Secretary of the Interior to address a request to the President of the National Academy of Sciences for an investigation and report upon the "inauguration of a rational forest policy for the forested lands of the United States." This brought forth the desired result, and—what was more—called a large public attention to the subject. Of the seven distinguished members of the committee appointed, the one who has since most greatly influenced this rational forestry policy in the United States, is Gifford Pinchot, since appointed Government Forester.

A prominent writer has said that there are few men at Washington who are likely to leave a more lasting mark upon the nation's economic life than Mr. Pinchot, who some six years ago became Forester of the United States. If he can carry out the great scheme of reforestation, afforestation, and forest reproduction which he has outlined, the influence of his work will be felt for a thousand years to come. Always a lover of the woods, Mr. Pinchot followed his course at Yale by studying forestry in European schools, and then returned to America to organize systematic forestry upon the Biltmore, North Carolina, estate of George W. Vanderbilt—the first private forestry work inaugurated in the United States. Appointed chief of the Division of Forestry in 1898, he found the Division's force numbering eleven members, with an appropriation for the fiscal year 1898-99 of $28,000. Secretary Wilson, his chief, lent the new Forester his enthusiastic support; and, from a small branch of the Department of Agriculture, forestry has become one of its most important parts. For the year 1900 we find the Forester's appropriation increased to $48,000, with 61 employees; and for 1901, to $88,000, with 123 employees.

A WINTER MOUNTAIN RESERVOIR.

Indicating how discharge of waters in springtime will be prolonged and regulated.

The Bureau of Forestry

In 1902 the Division was constituted a Bureau, with an appropriation of $184,000 and 205 employees; in 1903 the ap-

propriation was $291,000, with 250 employees; in 1904—the fiscal year just ended—an appropriation of $350,000 was provided, with some 300 employees; and for the coming fiscal year an appropriation of $425,000 has been made, with over 350 employees.

The Bureau of Forestry has thus, within a few years, become one of the great institutions of the Government; nor has it advanced beyond the growth of public sentiment; indeed it is scarce keeping pace with that sentiment, for the country has suddenly become alive to the necessity for this rational forestry policy. The preservation of the forests affects other interests besides those of lumber and wood supply. Streams are dependent for the continuity of their flow upon forest protection. The forest has been well likened to a great sponge which absorbs the bulk of the rainfall, allowing it gradually to find its way into the water courses through the medium of springs and brooks, thus furnishing an equable and perennial flow. Cut away this forest cover, leave the hills and the valleys bare and denuded, and the rainfall rushes down the unresisting slopes in torrential flow, cutting away the surface soil, creating gullies if not gulches, and leaving the ground in a short time dry and parched and the streams low in water. The evils of forest destruction in the watersheds have come home to many sections of the country, both east and west. It needs but a moment's intelligent consideration to see that the water supply of almost every city and town is menaced by reckless lumbering and forest destruction, while destructive floods are to a like extent augmented. In the West, where the water is the lifeblood of the land, being used for irrigation, forest destruction holds out fatal prospects. So the more intelligent communities are now not only striving to prevent deforestation, but are appropriating local funds to be used in co-operation with the national expenditures for reforesting bare slopes once timbered, which will then act as natural storage reservoirs for snow and water.

Irrational Opposition

Forest work and forestry education have been by no means an unopposed forward movement. Forgetful of the great areas of ruined lands extending from Maine to Michigan and Minnesota, which have resulted from clean cutting of magnificent timber, followed by forest fires killing a second growth, the forested sections of the far West have craved development and courted the expenditure of capital without the most thoughtful regard for their own real interests, to say nothing of the interests of posterity. The destruction of a timbered watershed here and yonder, by wasteful lumbering, has been regarded as a matter of only local interest at the most; while the investment of capital in mills, railroads, and the employment of large amounts of labor, has seemed more than an offset. The lumber capitalist has been

"Grizzly Giant," Mariposa Grove, California. Estimated to be over 4,000 years old.

hailed as a benefactor of the section, a creator of industry, and a distributer of wealth. The people have forgotten that the money would soon be exhausted, and the section left but a barren waste resembling a deserted mining camp. In fact, the bulk of the population in most of such cases have been but fleeting birds of prey, ready to move on to another timber belt—an ephemeral development and temporary prosperity, placing much money in circulation, but regardless of permanent results.

Rational forestry, however, does not contemplate placing a fence around a timber tract and erecting signs, "Keep out." The most serious apprehension regarding the creation of forest reserves and the scientific methods of forestry to follow, was that the policy would kill or largely curtail the lumbering industry. To this objection Forester Pinchot makes the notable response:

EXAMPLE OF EROSION, SAN BERNARDINO FOREST RESERVE, CALIFORNIA.

Washed gully in foreground. Bull pine forest in background.

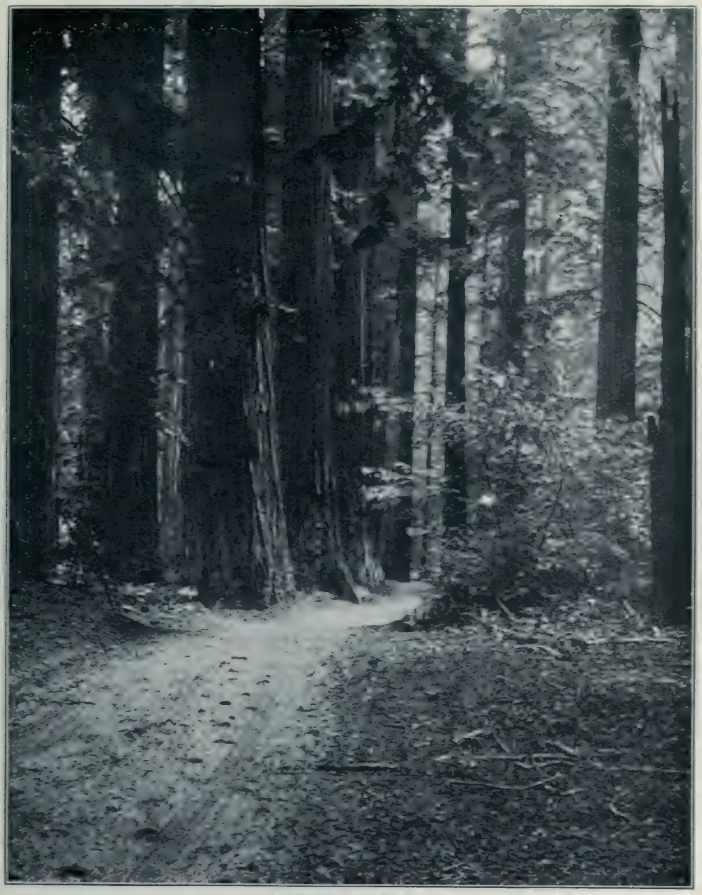
"I am not a preserver of trees. I am a cutter-down of trees. It is the essence of forestry to have trees harvested when they are ripe, and followed by successive crops. The human race is not destroyed because the individual dies. Every individual must die, but the race lives on. So every tree must die, but the forest will be extended and multiplied. It by no means follows that the face of the land shall be denuded so that the character of the watershed shall be altered, with the resulting injury to streams and to agricultural lands dependent upon them."

There is inspiration, says William E. Smythe, in the work to which Gifford Pinchot has set his hand. He is not only aiming to establish a forestry system under which existing timber belts shall yield their product forever in regular crops, but to make trees spring into life where they have been wantonly destroyed, and even where they have never grown within the memory of living man. His is not a work alone of government forest management. His Bureau is working in close and constant co-operation with the owners of private forest lands. Applications have already been received for government instruction and co-operation in the handling of over five million acres of private forests; and the advice of the Forester is constantly sought by forest land holders, ranging in extent from the farm wood lot to the great estate. Mr. Pinchot's methods and policy have won the respect and attention of all classes. One of his first statements following his appointment to his present position, was that he fully acknowledged the hard business sense of the American lumberman; that he did not expect to be able to instruct him in lumbering methods; but that he did believe he could show the owners of timber tracts, where, by the cost of a few cents an acre, their timber tracts could be lumbered and then left in a condition to produce another crop of timber, rather than to become waste and practically worthless land.

Tree Planting

The work engaging the Bureau of Forestry is most broad and comprehensive. It even includes tree planting, which is not a branch of forestry in its strict sense; and many sections, particularly in the West, can attest to the beneficial effects upon the climate which have resulted from the planting of thousands of acres to trees. Large areas of the once "treeless plains" are now thickly interspersed with wood lots and with checkerboards of wind-breaks. Nebraska claims upwards of 200,000 acres of planted trees; and Kansas, 150,000 acres. Of these, the cottonwood, the ash, the black walnut, the catalpa, the locust, the

Russian mulberry, and other quick-growing trees have been utilized, supplying fence posts, railroad ties, and even building lumber. The Bureau of Forestry recently issued a bulletin on "The Hardy Catalpa," a quick-growing tree of wide range and producing wood of great lasting qualities. Fence posts and ties which, in contact with the soil, will endure for thirty and forty years, can be grown in ten to fifteen years. Good telegraph poles are produced in twenty years. Kansas has three catalpa plantations of over 400 acres each. Planted 4 by 4 feet the trees grow straight and tall, and can be thinned as desired. Returns from these plantations show that they have yielded greater profits per acre than could have been derived from ordinary farm crops on the same land, in the same length of time. A plantation of C. W. Yaggy, near Hutchinson, Kansas, showed a net value, when ten years old, of $200 per acre, or a profit of $20 per



FOREST GIANTS.

Grove of Big Redwood Trees (*Sequoia gigantea*), Humboldt County, California.

READY FOR THE CARELESS SPARK.
Unburned Stump Land, Douglas County, Wisconsin. A Typical Example of Wasteful Lumbering.

year. Timber crops require but little attention.

The Working Corps

The working force of the Bureau of Forestry is variable. Mr. Pinchot's policy contemplates not only present forest results, but the training and education of men to carry on the rapidly increasing work of his Bureau. It has been difficult to secure enough trained foresters to enable the Government to push forward its plans. An inspiring sight greeted the writer at a recent fortunate visit to the Bureau. Nearly a hundred young men, fresh from technical forestry college courses, were congregated about the various offices of the Bureau, shaking each others' hands, and conversing eagerly and enthusiastically over their proposed field work for the coming season. They were about entering upon a postgraduate course in forestry—practical field work, where they would be turned loose in the woods, to apply, under technical guidance, some of their theoretical knowledge, and grow into real foresters. The pay of these young men, outside of their expenses, is nominal; but the Forester says that while it is looked upon as a privilege to secure such an appointment, and while the boys are inexperienced and green, yet the Government, outside of the benefit it will receive from moulding this raw material into

A California Lumber Camp.

practical workmen for future use, pecuniarily benefits by the practice, since these

young men, in their enthusiasm and willingness, do better work than the Government can secure from hired helpers at double the expense. The Bureau is building up a corps of young, vigorous, and practical forest experts possessing an *esprit de corps* perhaps second to that of no government bureau.

WHITE PINE TIMBER LAND CUT AND BURNED OVER, DOUGLAS COUNTY, WISCONSIN.
Land Left Practically Worthless.

Urgent Need of National Action

The time for the prosecution of national forest work on a large scale is critical. Vast acreages of the nation's best forests have been squandered; and the forces of greed and cupidity are still working to build up great private fortunes regardless of the rights of the people or the good of the nation. It is in the great West that our forest wealth now lies. A further wave of public education must sweep forward before the country will realize that certain radical changes are wise and necessary. The Government is still a great forest owner; that is, the people of the country own the remaining public lands and timber. In the West the sentiment largely prevails, that the public property of the West belongs to the West. This is not the case. There is no reason why the Government should practically give away this great resource; rather, it should administer it for the good of the whole people—those of to-day and those of to-morrow—and, in doing so, it should claim a legitimate revenue.

A principle was laid down to the writer, regarding forest management, by a government official, which will appeal to every business man in the country. He said:

"The Government is spending half a million dollars a year, getting *nothing* for it except indirectly. It should be spending five or six million dollars a year, and getting five or six or perhaps eight million dollars from such expenditure. Our forests should be self-sustaining. They should be cropped—the ripe trees harvested."

The President of the United States understands our forest problem better, perhaps, than any previous American President, though great credit is due to

President Cleveland for his forestry policy in creating the first forest reserves, some eighteen million acres, and in the face of the most violent opposition—the opposition of ignorance and misunderstanding. President Roosevelt, however, has made a close study of the forestry and irrigation questions. His recommendations and public utterances on these subjects are notable. His last message to Congress contains the following comprehensive paragraph:

Preservation of Forests

"The study of the opportunities of reclamation (irrigation) of the vast extent of arid

PLANTING A SLOPE WITH TREE SEEDS.
San Gabriel Reserve, California.

land, shows that, whether this reclamation is done by individuals, corporations, or the State, the source of water supply must be effectively protected and the reservoirs guarded by the preservation of the forests at the headwaters of the streams. The engineers making the preliminary examinations continually emphasize this need, and urge that the remaining public lands at the head-waters of the important streams of the West be reserved to insure permanency of water supply for irrigation. Much progress in forestry has been made during the past year. The necessity for perpetuating our forest resources, whether in public or private hands, is recognized as never before. The demand for forest reserves has become insistent in the West, because the West must use the water, wood, and summer range which only such reserves can supply. Progressive lumbermen are striving, through forestry, to give their business permanence. Other great business interests are awakening to the need of forest preservation as a business matter. The Government's forest work should receive from the Congress hearty support, and especially support adequate for the protection of the forest reserves against fire. The forest reserve policy of the Government has passed beyond the experimental stage, and has reached a condition where scientific methods are essential to its successful prosecution. The administrative features of forest reserves are at present unsatisfactory, being divided between three Bureaus of two Departments. It is therefore recommended that all matters pertaining to forest reserves, except those involving or pertaining to land titles, be consolidated in the Bureau of Forestry of the Department of Agriculture."

A bill is now pending in Congress—the result of the work of a commission appointed by President Roosevelt, of which Mr. Pinchot is a member—repealing the Timber and Stone Law, under which timber land can be purchased at $2.50 an acre, though much of this land is said to be worth $50 and even $100 an acre. The danger in the Timber and Stone Law lies not only in the actual

A 400-ACRE CATALPA FOREST IN KANSAS.
Trees about twelve years old.

money loss to the Government in selling valuable property for a pittance, but in the resulting denudation of timber tracts. This bill has already passed the Senate. It provides for the sale of government timber at its worth, and places the proceeds in the Irrigation reclamation fund. This process will therefore simply divert money received from one Western re-

source into another channel of Western development. At the same time the timber-cutting must be under the direction of the government officials, and carried on in such a manner as to insure a reproduction of the forest, the land itself to be forever owned by the Government. The Commissioner of the General Land Office has stated in an official report, that, under the Timber and Stone Law, the in local affairs, so that it is but natural that they should exert a large local influence and bring about an apparent condition of honest opposition to any such proposed "reform" legislation. But Congress will gradually be informed as to the facts, and a more rational and less wasteful policy will result.

With a broad national forestry practice, whereby the forest wealth of the

STAND OF YOUNG, EVEN-AGED RED FIR ON BURNED-OVER LAND.

Nesqually River Valley, Washington. Showing remarkably quick timber growth characteristic of the Pacific Slope.

Government has lost in actual cash between one hundred millions and one hundred and fifteen millions of dollars.

Much opposition to the repeal of this law has developed, just as there has been opposition to the proposed repeal of the Desert Land Law and the commutation clause of the Homestead Law, under which an equal squandering of the remaining natural resources of the Government is rapidly proceeding; but the opposition to this proposed reform comes from the sections in which live the men who are benefiting by them. These men are large operators, and powerful factors United States shall be jealously guarded and administered for the benefit of the whole people and for the good of the nation rather than in the interests of private speculation, and with the continuance and enlargement of the plan of government reclamation of the Great American Desert through irrigation, these two important internal policies of the United States will go down the decades and centuries as the most beneficent and far-reaching, in their results for good, of any of the great schemes for American development to-day advocated by economists and statesmen.

Submarine Mines

Types and Functions of these Effective Infernal Machines, which Sometimes Prove as Treacherous and Dangerous to Friend as to Enemy

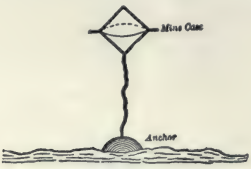
By ROBERT G. SKERRETT

Formerly of the Navy Department, Washington, D. C.

THE SUBMARINE MINE, which had its practical application first during the Civil War, has become to-day a very potent instrument of destruction, as shown by both the Russian and the Japanese losses in the present war, which have proved so expensive in both life and treasure.

The Birth of the Mine

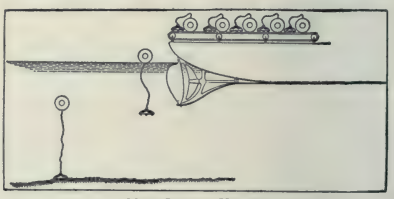
The submarine mine, or, as it was known in the days of the Civil War, the "torpedo," was born of necessity, and, during the years of that conflict, was peculiarly the weapon of the weaker side. Federal naval officers were led at first to belittle this system of defense; but after the Union cause had lost no fewer than twenty-two vessels and had had a dozen seriously injured, not to mention the loss of life—a record much more disastrous



CONTACT MINE.

Mine case held by cable just below surface. Anchor rests on bottom.

than that of any gun-fire—the submarine acquired a formidable dignity that has grown to-day to an exalted dread. Would space permit, it would be very instructive to trace the development of the submarine mine under the stress of the Confederacy's struggle—a record of varied and ingenious appliances that stands without a parallel in the annals of civilized warfare; but space does forbid, and the list of Federal losses tells plainly enough the deadly might of the crude, powder-filled, passive obstructions of a hard-pressed but fertile foe forty-odd years ago. To-day, gun-cotton—substantially unaffected



MINE-LAYING VESSEL.

Mines, with anchors, are dropped successively by means of traveling belt as vessel moves ahead.

by water—has supplanted the short-lived, damp-killed powder of the past; and, in replacing that old explosive, has brought to the modern mine, pound for pound of charge, a destructive might four times as great.

Its Defensive Character

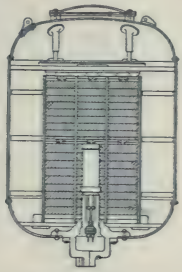
The submarine mine, unlike the torpedo of to-day, must be sought by the foe; and its prime weakness, of course, lies in its immobility. Secrecy of emplacement and well-guarded approach are vital to its efficiency; and, for this reason, the present mine is only one part of an extensive system of defense, instead of the prime obstruction, as it was during the days of the Rebellion.

The modern submarine mine differs in character with the work for which it is designed; and, broadly, the distinction is

Diagrams from "Textbook Ordnance and Gunnery," by Lieut.-Commander W. F. Fullam and Lieut. T. C. Hart, U. S. N.

made between those intended to explode by direction from an observation station ashore, and those that are fired automatically upon contact with the bottom of an enemy's ship.

It has become axiomatic in military circles that *"the defensive can only avoid defeat; it cannot win victory."* Such, in substance, is the mission of all our fortified seaports. The batteries there can only repel the foe; they cannot go forth as a fleet, and wring victory from the enemy: at most, they can prevent a determined naval antagonist from running by at all hazard to reach the cities lying back of these bulwarks. The prime object, then, is to prevent this; and to that end, the aim is so to limit and obstruct

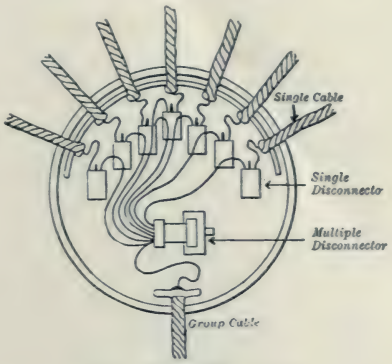


Observation Mine.

the approach of a foe that he shall be forced to make a frontal attack in line with the heaviest and the most powerful of the defending ordnance.

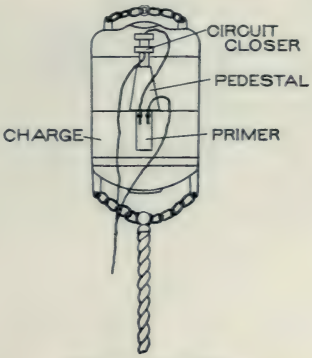
First and Second Lines

To accomplish this, submarine mines of various sorts are planted throughout the waters leading to a fortified position. By thus covertly guarding the flanking avenues of approach, it is possible to bring to bear upon an enemy a superior force at the point of attack. To this end, the navigable waters leading to a fortified position would be planted with a double line of mine defenses, the first line seaward, or distant from the heavy-gun emplacements, about 3,500 yards. At that range, the most powerful of the guns should be able to pierce the heaviest of the enemy's armor, and, before he could come closer, the aim would be to destroy his stability, injure his manœuvering powers, and thus prevent the successful retaliation of his own guns—in other words, to hold him at arm's length, and to cripple him beyond thought of further



Junction-Box of Mine System.

venture. The second line of mine defense is to detain the enemy still further, and to hold him in the face of the combined attack of all the guns—slow and rapid-fire—and effectually to check the



Electro-Contact Mine.

Held in position by anchor chain. Circuit can be broken from shore at will, to avoid danger to friendly vessels. When circuit is closed, collision with mine causes explosion.

smaller and more elusive of an attacking fleet that might slip through the slower fire of the heaviest guns.

How Mines are Guarded

To insure the effective working of the mine fields, they must be guarded against the counter-mining efforts of an active enemy; and for this purpose lighter bat-

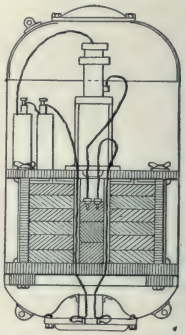
teries of rapid-fire guns and searchlights are installed to sweep all avenues of approach, and effectually to repel the small craft, to whom such work is generally intrusted by the foe. The aim is not only to destroy all vessels attempting this work, but to hold such craft at a distance so that they shall not be able even to

EXPLOSION OF CONTACT MINE LOADED WITH 75 POUNDS OF GUN-COTTON.

locate the position of the mine fields; for *it is in the secret, hidden nature of such defenses that their moral force lies, even more than in their applied destructive power.*

Systems of Planting

The work of planting a mine field involves no little preparation, for, as must be understood, the modern mine is rather complex in its installation in the fairways of commerce; and, of course, the idea today is to provide an efficient defense while still leaving the channels of traffic open to free passage during daylight and at such other times as may be secure from an enemy's approach. For this reason, the mines planted in a harbor-way or the navigable waters of seaboard ports, are placed deeper than the type designed commonly to explode on contact; and, to make them effective, they carry a much larger explosive charge, must be structurally stronger to withstand the water pressure at the greater depths, and are, in consequence, very heavy. In fact, the large, modern observation mines weigh quite half a ton, and their proper planting involves a deal of careful handling and a wealth of special facilities that cannot be enumerated in a brief sketch of the subject. Let us dwell, instead, upon the principal features of the mines themselves, which, while differing in minor details in most countries—the secrets of which are sooner or later known to all military experts—are fundamentally the same, for the fields of employment remain identical and fairly constant.

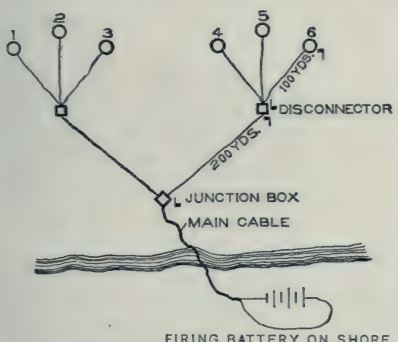


ELECTRO-MECHANICAL MINE.

Observation Mines

Taking the mines in their order of relative safety to those planting them, the Observation mine naturally comes first. This type of mine is shown in accompanying diagram (p. 139). The casing is of steel, and large enough to be buoyant when loaded with 500 pounds of wet gun-cotton, packed in a copper vessel with perforations permitting the entrance of sea water. In the lower center is the primer of dry gun-cotton, and the detonator of fulminate of mercury. The area of destruction of such a mine is a circle with a 60-foot diameter. These mines

are generally planted in groups of 3, 5, or 7, with battery connections leading back to a single junction-box containing as many disconnectors as there are separate mines. The purpose of this is, first, to centralize the connections of the mines, and then, by the separate disconnectors, to prevent the discharge of a single mine from short-circuiting and cutting out the rest of the group from subsequent control. The main multiple cable is led from the junction-box shoreward to the observation station, where each mine has



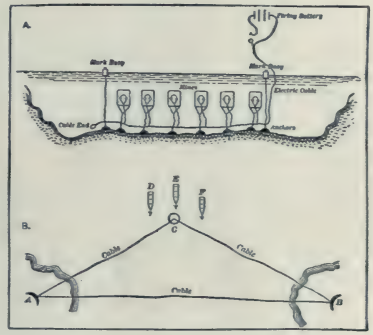
Groups of Contact Mines, Plan View.

its button on an elaborate keyboard. These mines can be exploded either singly or in groups.

The effectiveness of the observation mine depends upon accuracy in locating the enemy over them. This is done by cross-bearings, which, however, may be more or less indistinct or invisible by reason of atmospheric conditions. The act of discharge is effected by an electric current, which, heating a platinum filament in the primer, ignites the fulminate of mercury, which sets the explosive chain in motion. In principle of firing, the observation mine is not unlike the explosive sequence in the Whitehead torpedo. Until the firing key is pressed, the observation mine is pre-eminently safe and will stand a lot of rough handling, for the primer is pretty securely housed within the mass of the insensitive wet gun-cotton.

Electro-Contact Mines

The Electro-Contact mine is made either of iron or of steel, as conditions suggest, and may be either spherical or cylindrical, as shown in the diagram. Being intended to explode only when in actual contact with the bottom of a vessel, they lie nearer the surface, and carry a moderate charge of 75 pounds of gun-cotton. No craft has yet been fashioned that can resist the under-water attack of such a weapon. These mines differ radically from the observation mine in their method of firing. Within a pedestal in their upper half, they carry the bared ends of the firing circuit—one at the top and one at the bottom. This pedestal is partly filled with mercury, which, when the mine is tipped about seventy degrees, bathes both of the bared ends of the firing circuit, thus forming a continuous metallic connection, and closing the circuit. The circuit so closed heats a platinum filament which fires a primer similar to that in the observation mine.



A. Mine System on Single Cable across Harbor Entrance. Line of sight between mark buoys indicates vulnerable position of passing vessel.

B. Observers, with telescopes trained at a certain angle, are stationed at *A* and *B*. When vessel *E* comes into view of both observers, she is directly over mine *C*, and closing of circuit will cause explosion.

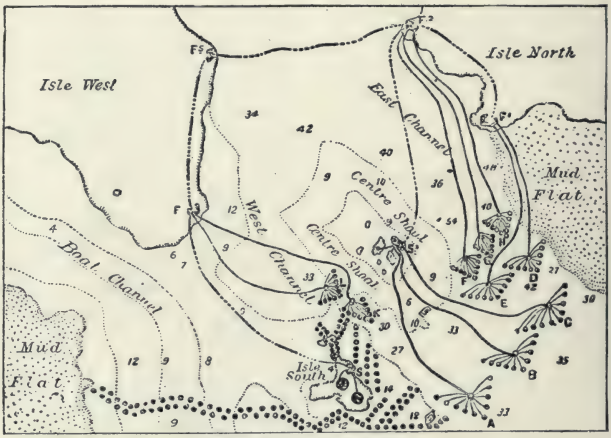
These mines also are planted in groups, and have junction-boxes and disconnectors, as do the observation mines. Until their battery connections are made ashore, they are of course harmless even when struck by a passing vessel. By plugging a diagrammatic keyboard, single mines or groups are made either operative or inoperative as the case may be; but, when once the battery connections are made, the mine becomes its own lookout, and should an enemy's ship

make the fatal mistake of bumping against it, the mine will do its deadly work without further aid.

Automatic Mines

The Electro-Mechanical, Electro-Chemical, or Automatic mine, as it is variously styled, is by long odds the most dangerous to handle. Once laid, they become a common menace to friend and foe alike. They are complete unto themselves, and entirely independent of extraneous control other than the unfortunate bumping of a doomed craft. Such were the mines the Japanese planted outside of Port Arthur; and such, too, were the mines with which the Russians in turn caught the Japanese battleship *Hatsuse*.

In construction, the automatic mine is substantially similar to the electro-contact mine, the difference being that the firing battery is contained in the mine itself, and is of power sufficient to heat the delicate platinum wire passing through the middle of the detonating fuse. This mine, too, has a mercurial circuit-closer, and it must be tipped over to an angle of seventy degrees to cause it to explode. To make these mines inoperative until they have been properly planted—for all mines must be anchored at certain depths, varying accordingly as the mines differ—there is a circuit-breaker consisting of a composition of sugar and powdered chalk (good non-conductors), which separates the ends of the wires in the mercury cup. This composition is poured in and allowed to crystallize long before the two small batteries are put in place. In a brief while after the mines are placed in the water, this composition melts and the weapons are ready for instant service. The electro-chemical mine is similar in principle, differing only in the nature of the material of the circuit-closer. An acid is set free by the tilting, which, by coming in contact with the two elements of a battery attached to the ends of the firing-circuit wires, creates a current strong enough to heat the platinum filament of the primer.



PLAN OF A MINE FIELD.

Mines are distributed in groups and electrically controlled from shore. Vessels avoiding one group will certainly pass over another. Whole field is swept by battery fire, and illuminated by searchlights at night, to prevent counter-mining.

Naval Defense Mines

There is a form of electro-contact mine now carried by the heavy fighting ships of a number of nations, called the "Naval Defense" mine. These mines are intended to protect a hastily established naval base on the enemy's coast or at

some point not otherwise defended. They differ from the ordinary electro-contact mines only in the absence of a shore-battery connection. After these mines are planted and the mine-laying vessel or boat is at a safe distance, a small battery, in a water-tight case and connected by a number of yards of small, insulated cable, is thrown overboard; and then—and then only—the mine becomes dangerous to any craft hitting it. To recover these mines in safety, the battery-boxes are swept for, raised, and disconnected, after which the mines themselves may be recovered without danger. Mines of this sort can be laid and recovered very rapidly, even during the heat of action; and, by an ingenious arrangement, they are made self-anchoring at a predetermined depth.

Counter-Mining

Counter-mining is the work of rendering an enemy's mine fields ineffective, either by cutting his electric cable connections or by exploding the mines by the shock of counter-mines fired in their neighborhood. This work involves a great deal of risk, is very hazardous, and must be carried out under cover of night or fog and with the utmost deliberation. The chances of its success are reduced to a minimum in the face of the powerful electric lights and the rapid-fire guns that should always command the approaches to the mine fields. Men there are in plenty who can be found at all times to undertake the tasks of such forlorn hopes, and in that readiness we see how little the awfulness of modern weapons of war will halt a gallant and persistent foe.

Automatic Appliances for Handling Coal and Iron Ore

A Description of Some of the Most Important Modern Adjuncts of the Lake and Railway Carrying Trade

By WALDON FAWCETT

IT IS SAFE TO SAY that in no other one division of the commercial and industrial world has the past quarter of a century witnessed the rapid, continuous, and truly phenomenal development which has characterized the evolution of means and methods for handling coal and iron ore in the transit of these most important of raw materials from mine to furnace, or, in other words, from Mother Earth to the finished product. To so high a state of perfection have the utilities employed in the handling of these bulk commodities been brought, that the dawning years of the twentieth century find practically the entire movement from mine to market accomplished solely by mechanical means.

Surpassing as the achievements of the past score and a half of years have been in labor-saving, and consequently in the cost of handling iron ore and coal, they have not been more wonderful than the economies of time effected by the more rapid handling of the world's two most important minerals. It is indeed a far cry from the old method of trundling small loads of the bulk material back and forth in wheelbarrows, to the new plan of transferring a carload of coal per

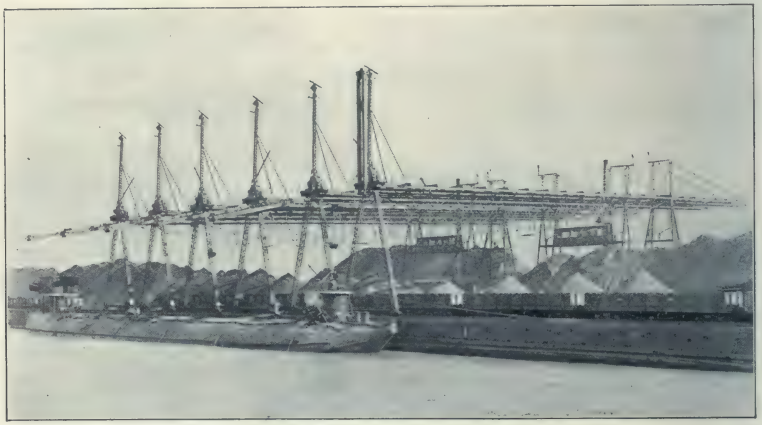
minute or to the moving of ore by means of grab buckets that scoop up automatically anywhere from two to ten tons at each operation; and yet, as has been said, less than thirty years has been required to work this amazing transformation.

The conditions governing the movement of iron ore and coal in the United States are peculiar in that several rehandlings are necessary. The major portion of the iron ore is mined in the States of Minnesota, Wisconsin, and Michigan; transported by rail to ports on Lakes Michigan and Superior; and then loaded on vessels which in some instances carry it to blast furnaces located directly on the shores of the inland seas, but which more frequently transport it to harbors on the south shore of Lake Erie, where there is a transfer from the vessels to railroad cars, in which the ore is moved to the blast furnaces of that great iron-manufacturing section known as the "Pittsburg District." Here, finally, there is still another rehandling when the ore which has been placed in stock piles is, as occasion requires, conveyed to the furnaces. The anthracite coal from the Pennsylvania field, and the bituminous fuel from the mines of Ohio, Pennsylvania, and neighboring States, which are shipped to points in the West and Northwest, traverse in the opposite direction practically the same route followed by the iron ore, and are subject to the same rehandlings.

The pioneer inventor who successfully solved the problem of handling coal and iron ore over a considerable range of distances solely or largely by mechanical means, was Mr. Alexander E. Brown, the well-known American engineer, the machines of whose invention are to this day accepted as the standard—and are indeed the sole—means of performing many of the functions in this highly specialized field.

Bridge Tramways

At the outset all the operations of transferring iron ore from ships to cars or stock piles, as the same might be, and of both loading and unloading coal-carrying vessels to and from cars or stock piles, were confined to a single class of apparatus—hoisting and conveying machinery of what is known as the "bridge tramway" type; and this form of handling appliance is yet so extensively used in moving both commodities as to merit first attention aside from its claim by reason of priority of invention.



BRIDGE TRAMWAYS FOR HANDLING ORE AND COAL.

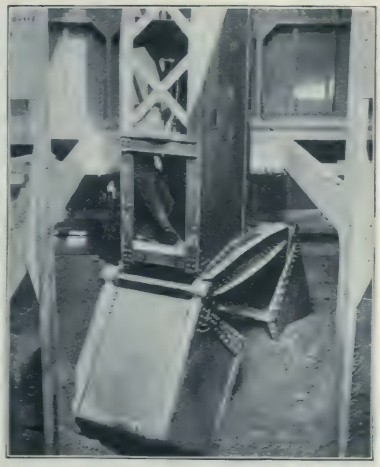
A bridge tramway is, in effect, a miniature elevated railway along which loads are conveyed by the trolley system now so extensively employed in the industrial field. The skeleton bridge structure—supported at both ends by piers—is built of

iron and steel designed to give the maximum strength with the minimum weight of material, and with all members made of such shapes, and so arranged in the trusses, as to offer the least possible surface to wind-pressure—an important consideration owing to the exposed locations in which these machines are generally used.

The bridge tramways proper usually range from 180 to 192 feet span; but, extending from the front pier, is a 34-foot apron reaching from the front of the dock out over the vessel tied up for unloading, while from the rear pier is a cantilever extension stretching back from 80 to 104 feet additional. Thus an area more than 300 feet wide is served by the tramway. The piers are of steel construction, and are high enough to support the bridge on an incline with the front end about 27 feet above the ground and the rear end 52 feet above the level. The piers are mounted on wheels running on tracks, so that the whole structure may be "skewed" or moved sideways back and forth along a dock to suit the hatches of a vessel. Thus a vessel may be unloaded by having several bridge tramways operating simultaneously over as many different hatchways or openings in the deck; or the cargo may be removed by a single tramway adjusted so as to operate in first one division of the hold and then another, by means of the sidewise movement of the apparatus.

Running along a track suspended from the bridge between the girders, is a trolley with suspended bottom block and hook to which is attached the hoisting or pulling line, and all the motions of which are under perfect control of the operator by means of suitable levers. Up and down this trolley line, at a speed of hundreds of feet per minute, travels an iron tub or bucket in which the ore or coal is carried. These buckets are made in various sizes; but what might be termed the standard size has a capacity of seventeen cubic feet (or a gross ton) of ore.

The plan of operation is practically the same in all cases. If coal or iron ore is being unloaded from a vessel, the operator, upon receiving from the hold of the vessel a signal that a tub is filled, throws the proper lever, and hoists the bucket at full speed through the hatch of the boat, the bottom block hooking automatically into the trolley, and the trolley carrying the heavily laden bucket to a point on the bridge or cantilever where its progress is arrested by dumping-irons placed at any desired location. These irons automatically trip the latch



"Clam-Shell" Bucket for Automatic Unloading. Showing Operator in Mast.

of the bucket, allowing it to upset, discharge its load, and automatically right itself. As soon as this is done, the operator releases the lever, and the bucket returns by gravity to its starting point in the hold of the vessel. The block unhooks automatically from the trolley, allowing the bucket to be lowered into the hold, whereupon the empty bucket is unhooked and a filled one hooked on. If preferred, the operator, instead of allowing the bucket to dump automatically, can lower it to any desired point for discharge, this being desirable when it is the purpose to transfer the coal or ore directly to waiting railroad cars.

One of the buckets such as have been described, will make a round trip from the hold of a vessel to the end of a bridge tramway trolley line, and return—a distance of 600 feet—in one minute: and in actual work a rate of forty-five seconds

per round trip has been averaged for hours at a time. If the filling, handling, and hooking-on of buckets be done with reasonable dispatch, a single machine will readily transfer 400 gross tons of ore per day of ten hours. The cost of handling coal and ore by this means varies from seven-tenths of a cent to two cents per gross ton.

The first bridge tramway plants were erected on the iron ore unloading docks at Cleveland, Ohio, about twenty-five years ago, and the new machines were for a time confined in their sphere of usefulness to the empire of the Great Lakes. Gradually, however, they secured general adoption, particularly for coal handling; and they are now to be found, not only on the Atlantic and Pacific coasts, but in Germany, Austria, Russia, Sweden, Egypt, and other foreign countries. Perhaps the best exemplification of the possibilities of this Yankee invention for coal handling, is afforded at the coaling stations of the United States Navy at Key West, Dry Tortugas, Mare Island, Cal., and New London, Conn., where, by means of bridge tramways such as have been described, fuel is transferred directly from storage buildings (having a capacity of 10,000 tons each) to the holds of United States war vessels.

FOUR HULETT AUTOMATIC ORE UNLOADERS TAKING ORE FROM A LAKE VESSEL.

Grab Buckets

During the early history of the bridge tramway plants, there was universal employment of tubs or buckets which, although self-dumping, had to be filled by hand. As an improvement upon these, there have been introduced various types of self-filling and automatic dumping buckets which will handle from two-thirds to four-fifths of a cargo or consignment of the bulk material without hand-shoveling. The most primitive forms of these self-filling buckets were "shovel" buckets of five tons' capacity, which scooped up their load through being dragged against the slope of the coal or ore pile. Then came the "grab" buckets, descending with open jaws, which, closing, took from the ore or coal pile a "bite" of one ton or more and held the material securely until released at any desired point of discharge. This class of buckets were introduced, not only in connection with the familiar bridge tramways, but also in conjunction with wire-rope cableways. The latter have been utilized to some extent for coal and ore handling, in locations where the span necessitated was greater than could be successfully covered by a suspension structure of the weight of a bridge tramway.

Clam-Shell Buckets

The most recent advances in ore-handling machinery have been along the development of appliances possessing the basic principle involved in the grab bucket above mentioned. The supreme triumph in this field is found in the lately devised automatic ore unloader, which, by means of a clam-shell attachment—an enlarged edition of the grab bucket—will take ten tons of ore from a ship's hold at each operation, and by means of which it is possible to remove every ounce of ore from a cargo-hold, thus dispensing entirely with hand shoveling, and eliminating the last utilization of manual labor

AUTOMATIC FURNACE HOIST.
For Feeding Ore and Limestone to Blast Furnace.

in the handling of the raw material from the time it is mined by means of a steam shovel until it is mechanically dumped into the blast furnace which is to give it new semblance.

The Hulett Unloader

The Hulett automatic ore unloader, as the most perfect of these new appliances is known, is a machine which weighs fully 400 tons and has a height of 55 feet. It consists primarily of a foundation trestle, which is mounted upon wheels and which can be moved along the dock, the rails carrying the forward end of the trestle being directly on the brink of the dock, as in the case of the bridge tramways. Moving backward and forward on this foundation span, at right angles to the dock, is a heavy walking beam, attached to the outer end of which is the depending leg or mast that carries the clam-shell bucket used in dipping out the ore. The parallel motion keeps the leg always in a vertical position; and the weight of the end of the walking beam from which the bucket is suspended is counterbalanced by means of a hydraulic accumulator located at the opposite end.

To operate this ingenious apparatus, the walking beam is run forward until the depending leg is suspended directly over the deck of the vessel. Then the mast, which revolves in a complete circle and in which the operator is stationed, is lowered through a hatchway and turned in any direction, its radius being fully nine feet. When open, the clam-shell bucket has a spread of 19 feet. After the bucket has been closed by hydraulic power, it is lifted from the boat and run back over the dock, where its contents can, if desired, be discharged directly into the railroad cars which are to convey the ore to the blast furnaces. Only three men are required in order to operate one of these machines, which has a capacity of 250 tons per hour.

ORE-HANDLING APPARATUS AT BLAST FURNACE.

The world's record for the rapid handling of an ore cargo was made a short time ago at the port of Conneaut, Ohio, when four of these machines, in a total working time of 4 hours 43 minutes, removed from the steamer *James H. Hoyt* a cargo of 5,300 tons of ore. All the cargo was taken out by the machines, no cleaning up whatever by hand labor being necessary.

Furnace Hoists

The usefulness of new marvels for handling bulk materials is by no means confined to the transfer of coal and iron ore to and from ships, railroad cars, and stock piles, but is demonstrated in scarcely a less striking manner at blast furnaces and iron and steel making plants in general. Foremost among the utilities in this field is the furnace hoist and stock-distributer, which has done away entirely with the old-time dangerous and unsatisfactory method of feeding blast furnaces, and, by automatically charging the furnaces, dispenses entirely with the employment of top-fillers.

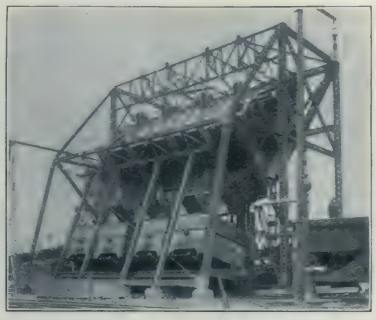
This hoist consists, in the main, of an inclined steel-trussed bridge starting from a pit and reaching to the top of the shell of the furnace, where it terminates in an extension over the top of the bell and hopper. A skip car with a capacity of from 2,000 to 6,000 pounds is arranged to run on this track, the hoist rope passing over the top sheave and back to the drum of the hoisting engine near the incline. When the skip car, loaded with iron ore, coke, or limestone, as the case may be, arrives at the top of the furnace, the car is automatically tipped, and the load is dumped into the great receptacle, from which the bell has been automatically lifted for the purpose.

At all blast furnaces the transfer of iron ore from stock or storage piles to the furnace as the raw material is required for consumption, constitutes a handling problem of some complexity. In this work there are employed steam shovels, locomotive derricks equipped with grab buckets, and, finally, various modifications of the bridge tramway. Some of the bridges thus employed have a clear span of about 250 feet over storage yard and railroad tracks, thus enabling the ore to be handled directly from railroad cars to furnaces, or from the stock piles where the surplus supply is held.

Car-Dumping Machines

Yet another form of apparatus which is being employed in handling both coal and iron ore, is the car-dumping machine. At the furnaces these dumpers are utilized in some instances to transfer the contents of standard-sized railroad cars to smaller cars which carry the material to the furnaces; but the true province of this type of apparatus is in transferring coal (for water shipment) from cars to colliers. In this field they have found extensive utilization.

There are in existence many different designs of car-dumping machines; but the most efficient styles are those which pick up and completely overturn the loaded car, transferring its contents to the hold of the vessel to be loaded. The earliest forms of car dumpers, while entirely satisfactory in the rapidity with which they handled material, were considered deficient in that they entailed a serious breakage of the coal. This, however, was finally remedied by modifications whereby the coal is dumped into pans connected with chutes leading to the vessel, which not only enable the fuel to be handled with far less breakage than formerly, but also make it possible to direct the influx to any portion of the hold desired.



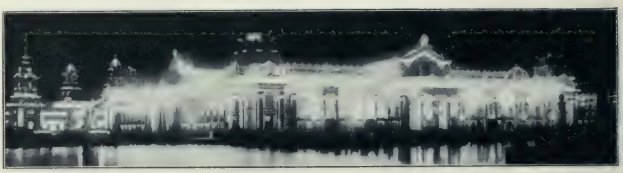
A Modern Car-Dumping Machine.

The fundamental feature of the average car-dumping machine is a car-tipping device or cradle into which the car is run and then clamped, and which turns over with the car and discharges its contents. In some machines the receiving pan is automatically tilted at an angle proportionate to that of the car-tipping device, so that the coal slides gradually instead of pouring or falling; and in certain machines the coal is not sent into the vessel hold through a chute, but is transferred from the car, as it is dumped, to transfer tubs or to steel buckets arranged on the endless-chain plan, which convey

it to the cargo space by easy stages and with practically no breakage. Some of these car-dumping machines will handle upward of 200 loaded cars in an ordinary working day, not only actually transferring the coal, but handling the loaded and empty cars to and from the machine, and obviating all necessity for the employment of a shifting engine and train-crew.

Coal-Loading Machines

An ingenious type of coal-loading machine is found at Fairport on the south shore of Lake Erie, and at several other points in the United States. By its operation the coal to be loaded on a boat is dumped from the hopper-bottomed railroad cars into a large receiving hopper underneath the car. From this hopper the fuel is delivered to a carrier of the continuous type, which hoists it up to an incline spout down which it passes into a telescope spout and thus directly into the boat. This telescope spout is drawn out to its full length at the commencement of operations, and is then gradually taken up or shortened as the boat is filled. By this means the spout is kept constantly full of coal, and the breakage of the fuel is reduced to a minimum. It requires but two men to operate such a machine, which is driven by a 50-horse-power engine. The cost of an installation of this kind is much less than in the case of some of the other types of coal-handling machinery, and yet such a machine is capable of loading from 600 to 900 tons of coal per hour.



A Quarter-Century of American Central Station Engineering

The Marvelously Rapid Progress in Electrical Engineering which has Revolutionized Industrial Conditions

Part III.

By R. F. SCHUCHARDT, B. S.
Testing Laboratory, Chicago Edison Company

Consolidation of Plants

THE NEXT STEP in the development was one of consolidation. Many cities had been liberal in granting franchises to lighting companies, and as a result there were built within the same city many systems of various excellence and stability. To the engineers of the consolidated company was then presented the problem of unifying the systems; but the changes to the new system had to be made without sacrificing the value of the investment represented by the generating apparatus and lines of the existing stations. Such a change, naturally, was made step by step, and thus required several years. In addition to providing for the existing load, the new system had to be designed for the future; and the probable development in the line of various classes of electrical apparatus had to be considered.

In our larger American cities, the load

conditions can be divided into two general classes—one, in which a large load is concentrated over a comparatively limited area, which is the down-town or business district; and the other, the residence district, where the load is widely scattered over a large area. In the down-town district nearly

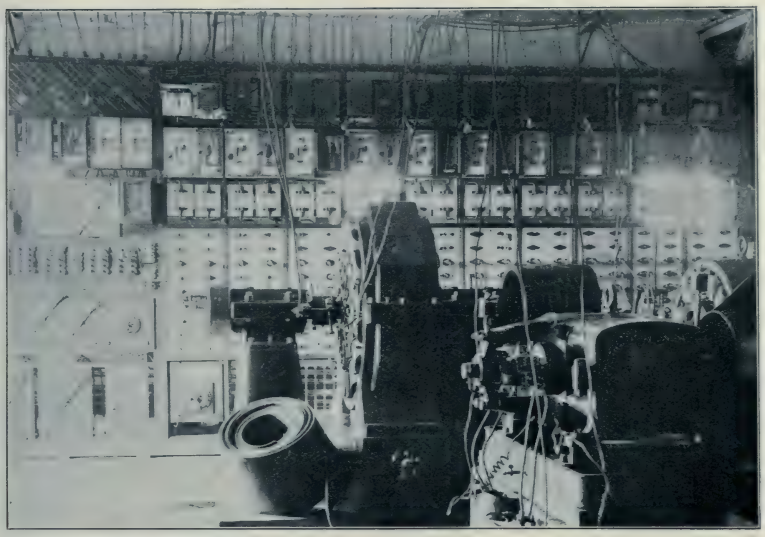


FIG. 19. EARLY ALTERNATING-CURRENT STATION.

30 per cent of the load goes to power users; therefore the system had to be adapted to all classes of motor service, as well as for lighting. For this service in such a district, the Edison direct-current three-wire system is certainly the most satisfactory, and this system has been pretty generally adopted. It permits the use of storage batteries; requires less copper than does the alternating-current system, because in it there is no loss due to inductance; gives better regulation; and is far better for general all-around power service.

To consolidate several systems of this class was a simple matter. It required merely that the separate networks of mains be tied together, and a uniform pressure kept on the system by each station feeding into it. In the outlying districts, however, the problem was more complicated. Because of the scattered load, most of the systems feeding these districts used alternating current. But there was a wide divergence in regard to frequency and voltage. Some of the lines were 1,000-volt; others, 2,000-volt. Some used a frequency of 125 cycles; others, 133 or even 144 cycles. The secondary pressure ranged from 104 to 125 volts, while some of the earlier systems still maintained a secondary pressure of 50 volts. A few of the later stations had 2,000-volt lines, with a frequency of 60 cycles; and there were also polyphase (generally two-phase) lines for serving a motor load. A view of some of these earlier alternating-current stations is given in Figs. 19 and 20.

High-Voltage Polyphase Systems

This conglomerate mass, then, had to be unified. A careful study of various systems showed the four-wire three-phase system, with a frequency of 50 to 60 cycles, to be the best suited to the distribution of such a load; and this system is being freely adopted. Good examples of it are found in Chicago, Milwaukee,

St. Paul, and Cincinnati. The generator for this system is star-wound, with the neutral grounded, as explained earlier in the paper. The voltage at which this system is generally operated is 4,000 between phase wires. This gives a pressure of approximately 2,300 volts between any phase wire and the neutral; accomplished by means of the ordinary 2,300-volt static transformers.

In Fig. 22 is seen a 150-light (7.5-K. W.) transformer hung on a pole. The two wires coming down at the right are the 2,300-volt primaries; while the three-wire secondaries, of 115 volts per side, are brought up at the left. Fig. 23 is a

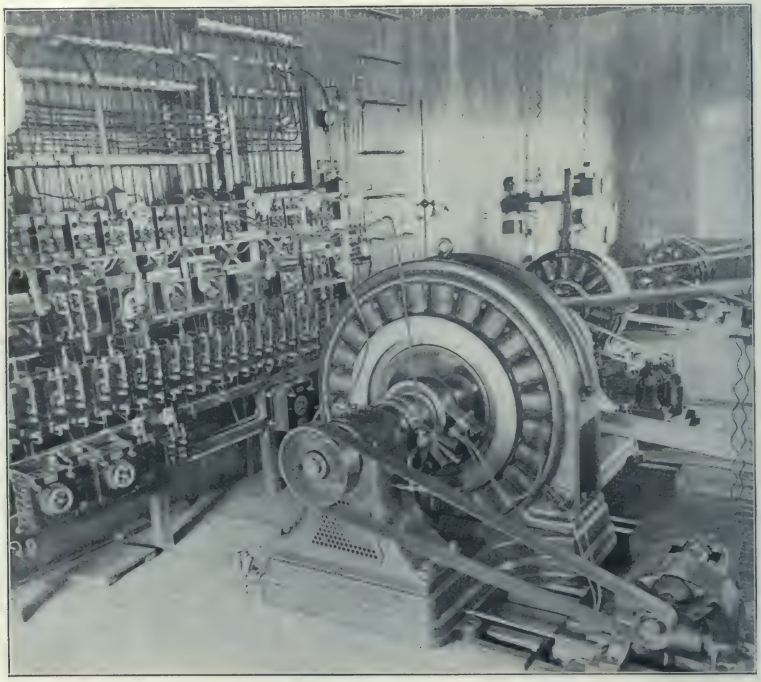


FIG. 20. EARLY ALTERNATING-CURRENT STATION

and the single-phase lighting feeders are switched on to this 2,300-volt connection. The various feeders are connected each to one of the phases and the neutral, so that the three phases are aproximately balanced. For a power load, then, connection is made to all three phases; and the motor is usually of the polyphase induction type, of which one is shown in Fig. 21. Where the capacity of the motor is very small—say under 3 H. P.—the single-phase type of induction motor, equipped with some special starting device, is often used. Stepdown of the voltage to the service pressure is, of course, pole line carrying principally alternating-current primaries. Transmission to substations, which in this case are merely distributing centers, is then done over the three phases at 4,000 volts, the neutral preferably being carried along also. At the substation, only feeder regulators are required beside the switching apparatus; and the feeders here also are connected between a phase wire and the neutral, 2,300 volts. A diagram of a four-wire three-phase distribution is shown in Fig. 24 (p. 154); and in Fig. 25 (p. 155) is seen a switchboard installed for such a system.

When the transmission distance is great, this three-phase pressure can be raised to any desired amount, and then stepped down again at the substation, the local distribution again being done on 2,300-volt single-phase feeders with 4,000 volts' pressure between phase wires. In some cities a two-phase system was adopted; while others, again, use the three-wire three-phase system (in which

FIG. 22. ELECTRIC LIGHT POLE, WITH 150-LIGHT TRANSFORMER.

a neutral conductor is not used and all load is connected between phase wires). Brooklyn has a two-phase 2,300-volt 60-cycle system in the residence section; Philadelphia also, though in the latter city the current is generated at 5,500 volts and stepped down to 2,300 volts for alternating-current distribution.

A 500-volt two-phase generator is shown in Fig. 26. For higher voltages the revolving-field type is used, thus avoiding collector rings and brushes for the high-voltage current. At the South Boston station of the Boston Electric Light Company (now part of the Boston Edison Illuminating Company), the generators are wound for 2,300-volt three-phase 60-cycle currents.

In the direct-current districts the load often increased very heavily in sections somewhat remote from the generating or the distributing center; and then it again became a question of more stations, more copper, or some other additional

FIG. 23. POLE LINE CARRYING ALTERNATING-CURRENT PRIMARIES.

means of transmission. To provide enough copper for satisfactory transmission and regulation, would bankrupt a company. To build and to operate a new generating station in each section of

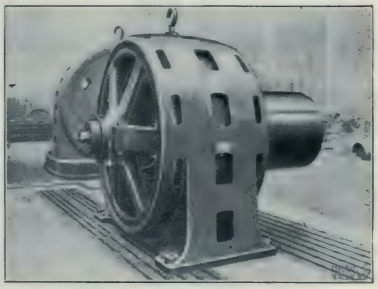


FIG. 21. POLYPHASE INDUCTION MOTOR.

heavy load, would be equally ruinous. Consequently recourse is had to other means of transmission. The success and the comparative copper economy of polyphase transmission lines, already men-

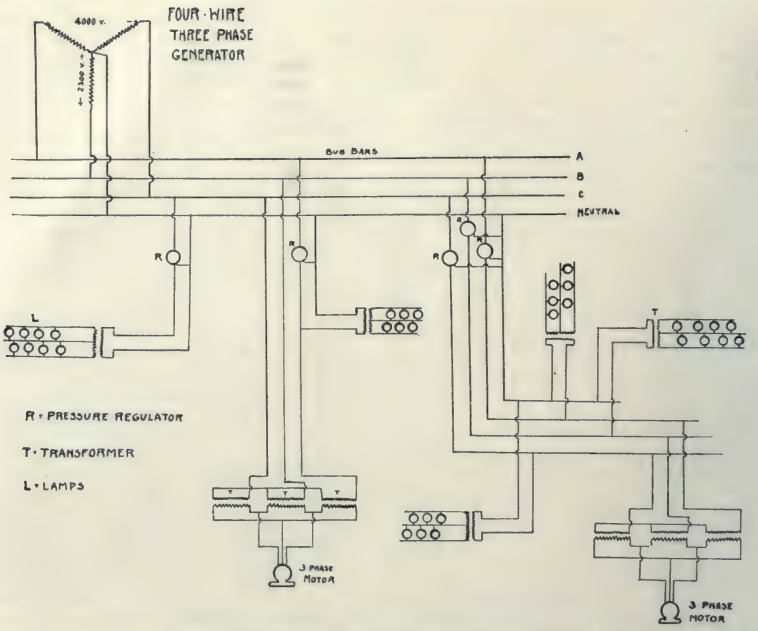


FIG. 24. CONNECTIONS OF 4-WIRE 3-PHASE DISTRIBUTION SYSTEM.

tioned, showed that system to be the proper one to adopt; and the three-phase system was chosen as the means to transmit current to substations located at or near the electrical center of the load. Such a transmission system, from a large alternating-current station in preference to several direct-current generating stations, is considered good engineering whenever the total energy generated is large as compared with that used at any one locality. The voltage determined upon depended to some extent on the local conditions, but more largely on the efficacy of the insulation of underground cables, since in the cities all lines must

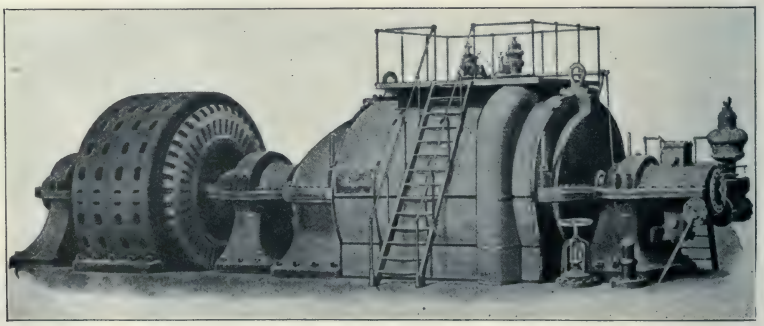


FIG. 29. WESTINGHOUSE-PARSONS 5,000-H. P. STEAM TURBINE GENERATING UNIT.

be below the surface. In the early days of underground cables 5,000 volts was thought very high pressure; to-day 25,000 volts is not considered excessive; and a recent article in an electrical journal* stated that an underground cable system will soon be installed, to be operated at 30,000 volts. Unfortunately the article did not state where this would be. The insulating material used in these high-tension cables consists of paper treated with a resinous compound, the thickness in the 30,000-volt cable being about one-half inch. Over this is a lead sheath about ⅛-inch thick, to protect the cable against moisture and mechanical injury. These cables are drawn into ducts laid below the surface in the streets, as shown in Figs. 3 and 4.

One of the earliest instances of the use of a three-phase transmission to a substation, for conversion to direct current of an Edison system, was in Chicago, where, in 1897, a 250-K. W. inverse rotary converter, which converted direct current of 250 volts to three-phase 25-cycle currents, was installed at the Harrison Street station. By means of step-up transformers, this pressure was raised to 4,500 volts, the pressure of the transmission. In the substation on Wabash Avenue near 27th Street, this voltage was stepped down again; and, after passing through the rotary converters, the current was fed into the direct-current system at 115 volts, one rotary being connected to each side of the Edison system. Such was the humble beginning of the very extensive system of high-tension transmission lines and substations which, at double the initial voltage of 4,500, is now in operation in Chicago.

In the same year there was installed in Brooklyn, N. Y., a similar transmission system with a rotary converter substation. Here the current was generated at 6,600 volts, 25 cycles, three-phase, at the

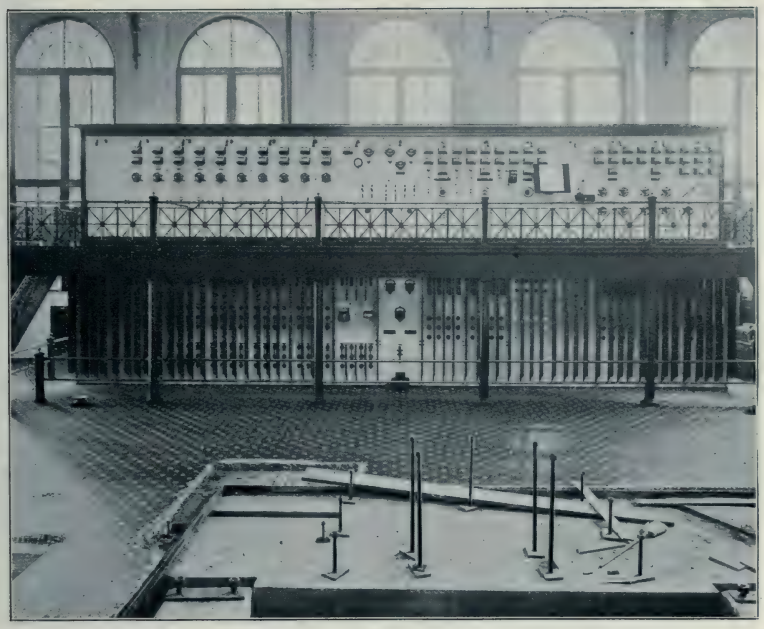


FIG. 25. SWITCHBOARD OF 4-WIRE 3-PHASE DISTRIBUTION SYSTEM.

Electrical Age, February, 1904, p. 68.

Union station, a similar system to that operated by the New York Edison Company. In the magnificent Waterside station of this latter company, there are at present eleven 5,500-H. P. vertical engines, each driving a 4,500-K. W. three-

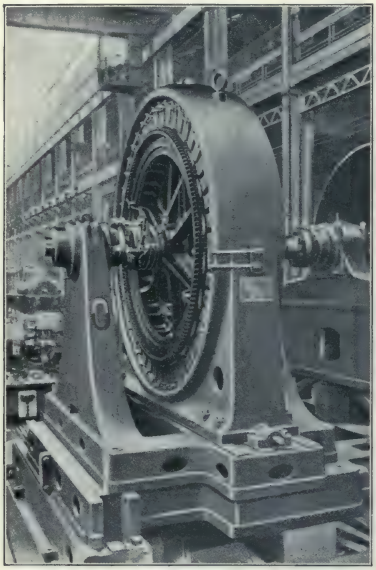


Fig. 26. A 500-Volt 2-Phase Generator.

phase 25-cycle 6,600-volt alternator. A 5,000-K. W. Curtis turbo-generator is being installed, and there is room for four more. This will make a total rated capacity of 75,000 K. W., all power being generated as alternating current for transmission to rotary converter substations, from which it will feed into the Edison three-wire direct-current system. In the splendid new Fisk Street station in Chicago, 9,000-volt 25-cycle three-phase current only is generated, all by Curtis turbo-generators. In Fig. 28 is shown a 5,000-K. W. Curtis turbine with generator; and Fig. 29 shows a Westinghouse-Parsons unit of the same capacity.

In Philadelphia the 5,500-volt two-phase 60-cycle system, already referred to, is used for transmission to rotary converter substations, as well as for the alternating-current distribution. Fig. 30 shows a row of rotary converters of a substation located in the basement of a sky-scraper in the heart of the business district of Chicago. The switchboard of a combined rotary converter and battery substation is shown in Fig. 31; the rear view, in Fig. 32.

Where the load connected to transmission lines consists solely of substation converting apparatus, a low frequency is desirable because of the accompanying low inductive and capacity reactance of the lines, and also because of the slower speed of the synchronous motors and rotary converters which is had for a given number of field poles with a lower frequency. The higher the frequency, the greater the number of poles required, or the greater the speed. Because of the necessary number of commutator bars required between the brushes of a D. C. machine, and therefore also on a rotary converter, the distance between the centers of the pole pieces (that is, the pole "pitch") cannot be less than a certain

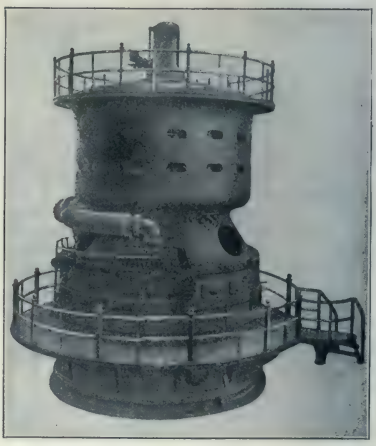


Fig. 28. A 5,000-K. W. Curtis Turbo-Alternator.

fixed limit; and therefore, for a given speed, the lower frequency requires a far simpler and cheaper construction. The higher-frequency machines are also more liable to "hunt," especially when the load varies considerably. Furthermore, double-current generators having a commutator connected to the armature wind-

ings for direct current, and also having connections to collector rings from which alternating current is taken off, are not practicable for frequencies much above 25 cycles. These double-current generators, producing both direct and alternating current at the same time, form a very valuable element in a large station in which both these currents are generated, the direct current for general distribution, and the alternating current for transmission to substations. A frequency of 25 cycles is therefore generally accepted as the most desirable for straight transmission; but the alternations are noticeable on incandescent lamps at even 30 cycles, while arc lamps will not burn at all satisfactorily on frequencies of less than 40 cycles. Because of these facts, the alternating distribution, as distinguished from transmission to substations, is effected by 60-cycle current. The 25-cycle transmission current is then converted to current of 60 cycles per second by means of motor generators or straight frequency-changer sets.

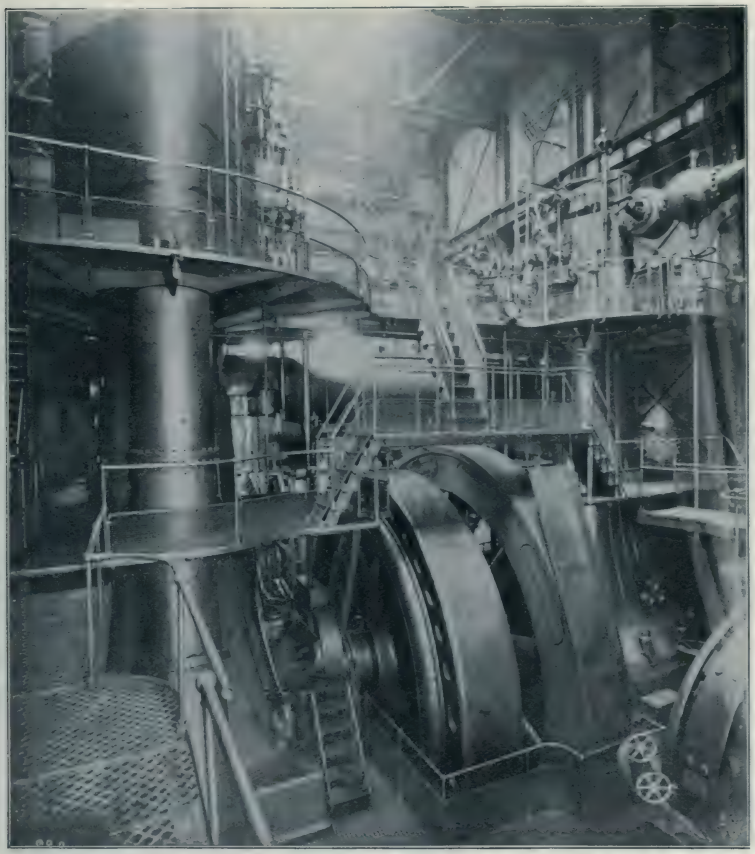


FIG. 27. A 3,500-K. W. ALTERNATING-CURRENT GENERATOR, HARRISON STREET STATION.

In Fig. 33 is shown such a motor-generator substation. The small units in the

foreground are exciter sets, that is, D. C. dynamos driven by induction motors and used to furnish the field excitation current for the motor generators. The high-

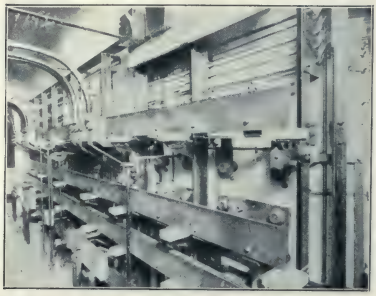


FIG. 32. REAR OF SWITCHBOARD OF ROTARY CONVERTER AND BATTERY SUBSTATION.

tension switches for the substation are controlled from the switchboard, and are located in the basement, with the high-tension busses. The switches are of the oil-well type, in which the circuit is opened in oil to prevent arcing with its often disastrous results.

In Europe a compromise frequency of 42 and sometimes 50 cycles is common; and current is transmitted and distributed at this frequency, thus requiring only voltage transformers and no frequency changers. A few 25-cycle systems have been installed in Germany. For converting to direct current, motor generators are used more freely than are rotary converters. European transmission lines of 10,000 volts three-phase are not uncommon.

With the advent of polyphase transmission in connection with lighting and power systems, the old 500-volt power lines are gradually being abandoned, the power load being connected to the 230-

FIG. 33. MOTOR-GENERATOR SUBSTATION. Exciters in foreground.

volt circuit of the Edison three-wire system, or, if in the outlying districts, to the polyphase 60-cycle lines. Series arcs have already been largely displaced by

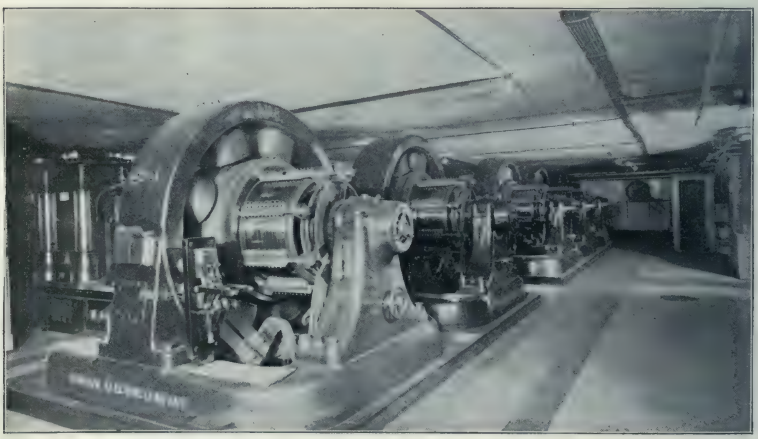


FIG. 30. ROTARY CONVERTERS INSTALLED IN SUBSTATION IN BASEMENT OF OFFICE BUILDING.

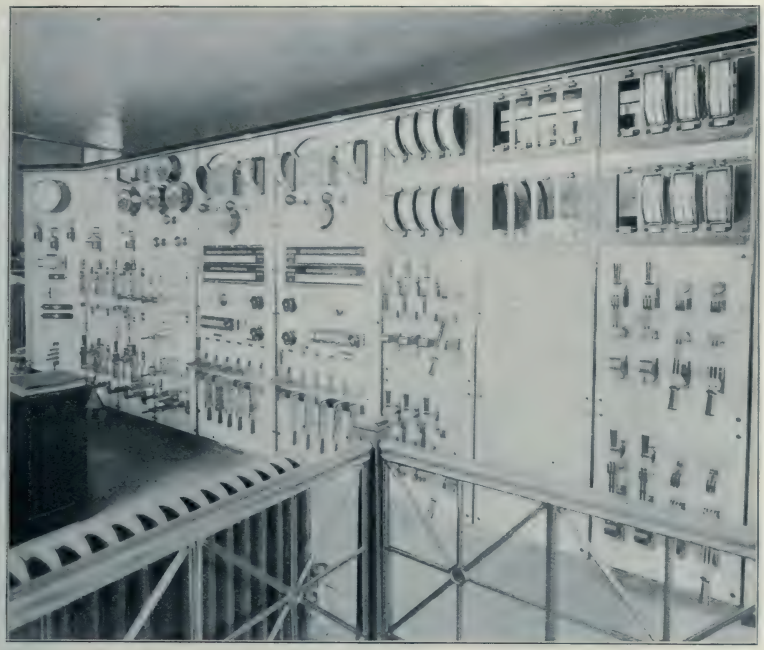


FIG. 31. SWITCHBOARD OF ROTARY CONVERTER AND BATTERY SUBSTATION.

constant-potential arc lamps. What this new system meant to the neighborhood in which the old stations were located, will be appreciated when one remembers the noise and dirt and smoke of these old stations, and then views Fig. 34, a substation set in the rear of a lot in a fine residence section.

We have seen, then, how the high-voltage polyphase system has been evolved out of, and has unified, the mixed systems which were brought under one head during the era of consolidation. A study of some of the newest installations leads to the thought that perfection of system has almost been reached, and that further progress will be rather along the line of higher efficiency of apparatus at both ends of the system. When the true electrical era has arrived, when houses no longer have need of chimneys and all operations are performed electrically, then new problems will arise. How they will be met, none can now say; but they will be met successfully. Another Edison — many of them, perhaps — will arise; and then our splendid systems of to-day may ultimately be supplanted by one of which the most imaginative dreamer as yet has seen no vision.

FIG. 34. MODERN LIGHTING AND POWER SUBSTATION.

A Locomotive's Life—Its Ups and Downs and Duration

By A. W. Mc COY

WHAT becomes of all the pins, and what happens after death to the splendid pieces of mechanism called locomotives, are by no means similar questions. Indeed, the theory of metempsychosis may well be applied to all railroad rolling-stock. Nearly every piece is saved and put to some use; has assurance of future existence, even as "scrap" for the furnace, from which it comes forth as new parts. "Reinferration," the process may be termed—to coin a word for such railroad phenomena.

The modern locomotive costs $15,000 or $18,000, according to size and equipment. Passenger locomotives in former days were embellished with extra brass-work and trimmings; the bright parts were kept by the firemen in a state of glittering effulgence; and the passenger engine cost more than the freight engine. Nowadays the trimmings are not put on; and the passenger engine, being lighter, costs less than the mammoth freighter.

When the engine goes into commission, it is a fine piece of machinery, with power to pull long trains over miles of tracks day after day; but, with the strenuous work, comes the certainty of deterioration and the necessity for constant repairs. When work was lighter, trains not so heavy, and mileage in lower figures, an engine could be expected to live thirty years; but in locomotives the tendency is towards a decrease of longevity, for the management strives to get all the service possible out of them. The age of expectancy is only approximate. Bad water—that is, water bad for the internal economy of boilers—which causes scale, is perhaps the greatest foe to an engine's hope for an honorable old age. A bad water division uses up its motive power far more rapidly than hard work elsewhere. Local conditions on the line largely affect the motive power. A hilly country causes more strain. Then too, housing facilities have much to do with the life of an engine. If it is possible to keep up with needs in repairs, the machine stands a better chance for giving long service.

A BRAND NEW PASSENGER LOCOMOTIVE.

Balanced-Compound—Vauclain System, with DeGlenn arrangement for transmitting power to axle.
Built for the Chicago, Burlington & Quincy Railroad.

Reprinted from *The Chautauquan.*

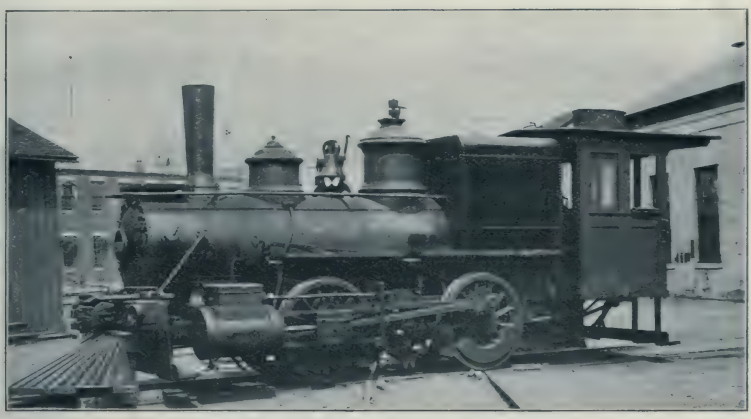
The demand for engines, however, may be so pressing that the least possible repairing that will answer is given, with the result that the locomotives constantly deteriorate and lose in efficiency until complete overhauling becomes a positive necessity.

At one time it was popularly supposed that the passenger engine was subject to the severer strain, but that was before the days of long trains and 100,000-pound cars. The freighter gets the worst of it under existing conditions. Fairly treated, the passenger engine, as compared with the freight engine, stands a chance of a one-third to one-half longer life, and then prolongs its life on a branch line or in some special service.

In the twenty years' estimated life of an engine, the expenditure for repairs will reach, in all probability, $30,000, or about twice the original cost.

Everything possible is done to keep the engine in commission, until at last a stage of decrepitude is reached that seems to preclude further repairs. At this point it is a question of "scrapping" the locomotive, or of selling it for about $2,500 to dealers in second-hand equipment, who will repair it for about as much more and sell it to a logging or similar road, where it may do service for several more years.

An old locomotive is worth as scrap from $500 to $2,500 as the case may be, the difference being due to the availability of the various parts for further use as such parts. When the engine is turned over to the scrappers, it presents a disreputable appearance, far removed from that of the days when its first engineer looked it over. Once dignified as "she," "old kettle" or "mess of junk" are now the most respectful epithets applied by those who have to do with its operation. Even in the days of scrapping, careful management guards against wastefulness. Steel, brass, and iron are taken off separately; everything usable is saved out; and frames, axles, and good parts are set aside for further use. What is left goes to the scrap bins and eventually to the foundry or the junk dealer.



A LOCOMOTIVE READY FOR THE SCRAP PILE.

Generally speaking, railroads prefer to sell their old engines and cars, if possible, and save the expense of scrapping, which naturally is considerable. That is why a number of concerns do a profitable business in old rolling-stock, and there is a demand from small railroads or self-contained lines for engines and cars which the trunk lines do not think it profitable to keep in stock.

In all railroad centers a constant watchful warfare is waged against thieves, who, many times in organized gangs, plan the removal of all detachable pieces of locomotives or cars. These

thieves carry wrenches with them; and, if great care is not exercised, they will steal brass and other fittings from locomotives in broad daylight, where they stand. The boldness of some of these attempts is remarkable; and the arrests and convictions which occur from time to time do not suffice to deter these criminals, some of whom are said to be actually in the employ of railroad companies as silent partners of those who carry away the spoils.

The life of a passenger locomotive may be approximated at twenty-two years; of a freight locomotive, at fifteen years.

Automatic Telephony

Its Mechanism Popularly Described—Its Advantages over Manual Operation

By H. S. DURANT

THE SPIRIT of the present age is not better shown forth than by the ever-increasing demand which industry, pressed by the keenness of competition, is making upon genius for the invention of labor-saving and time-saving machinery; and nothing pays higher tribute to the breadth of the human intellect than the character of the machinery which has been evolved as the result of this insistent call. Indeed, we are sliding rapidly into an automatic age. The work that once was done by hand, then by hand-guided machines, is now done by automatic devices. Scarcely a large, up-to-date factory but has in one or more of its departments a battery of automatic machines busily engaged in turning out such things as screws, buttons, tin cans, cloth, shoes, or a thousand other varieties of useful articles from the raw material, with surprising nicety and tremendous speed, reducing the cost of manufacture to a minimum and widening the field of sale. We have wondered at the ingenuity of these machines and marveled at their cleverness, but we have looked upon their invention and introduction as something that was

DESK TELEPHONE.

bound to come, as only another step in the logical order of things. We have waited for them, and have not, therefore, been surprised at their successful advent.

AUTOMATIC TELEPHONE EXCHANGE, GRAND RAPIDS, MICHIGAN.

Few of us, however, as we have stood before a telephone box, wiggling a switch hook, or whirling the crank of the hand generator, and impatiently waiting for time and the "Hello girl" to bring us our connections, have ever gone so far as to hope, or even conceive the idea, that this genius who had so long presided over the central office, would ever be unseated and her place occupied by an iron machine whose speed and accuracy would discount her best performances; and yet that day is here. The States are already dotted with automatic telephone exchanges, which are giving service to thousands and thousands of subscribers, and with such success that it is not hazarding anything to predict that a few years will see the absolute divorce of the operator from the exchange room—except, of course, for long-distance calls, for which her services will probably always be needed.

Historical Retrospect

The application of the automatic idea to telephony is not new. It is considerably more than a decade since Strowger, an obscure Chicago engineer, brought out the first automatic telephone. The Strowger Automatic Telephone Company and the installation of a number of small

AUTOMATIC TELEPHONE EXCHANGE, LINCOLN, NEBRASKA.

exchanges resulted. These exchanges were successful, not so much in what they actually accomplished in the way of improved service, as in the promise they gave of future development in that direction. The apparatus was crude, imperfect, and complex; but the fundamental ideas involved were right and required only better expression.

is already in operation; and others will be added as occasion demands, the ultimate purpose being to handle the business of the entire city.

The Automatic Mechanism

A study of the apparatus which has made all this possible will, no doubt, be interesting and instructive. The tele-

AUTOMATIC TELEPHONE EXCHANGE, DAYTON, OHIO.

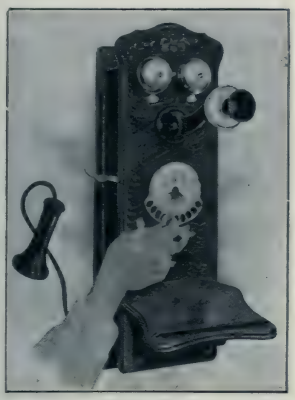
Ten years passed, ten years of experiment and persistent effort. Strowger died. The Automatic Electric Company was organized to take over the Strowger patents. Further experimenting was done, and greater capital expended. The result has been a system from which the imperfections have been eliminated, a system which is scarcely more complex than the manual switchboards now in general use. The limit of capacity is no longer reached at 1,000 stations. In fact, the business of the very largest city can be handled as efficiently and conveniently as that of a town which requires but a hundred telephones. In Chicago to-day an automatic exchange of 10,000 stations

phone itself resembles, in many particulars, the manually operated telephones with which we are so familiar. It consists of the usual transmitter, receiver, bells, battery, and induction coil, adding only a calling dial, a circular metal piece, on the periphery of which are ten finger holes numbered 1-2-3-4-5-6-7-8-9-0. A stop is provided at the lower of the holes to limit the distance which the dial may be made to revolve.

How a Call is Made

The method of calling is very simple. To secure a number, say 761, the subscriber first takes the receiver from the hook; then, placing his finger in hole

number 7, pulls the dial around to the stop above mentioned. When released, the dial is instantaneously restored to its normal position. The subscriber is now connected to a trunk line leading to the seventh group of so-called "connector"



WALL TELEPHONE.
Showing Method of Operating Dial and Making Call.

switches, which we may call the "seven hundredth" group. In the same manner he calls 6 and 1 in this group. Having turned the number desired, he presses a button underneath the dial, which rings the bell of the person wanted, and the connection is completed. In the event that the 'phone of the subscriber called is busy at the time of the call, a vibratory sound in the receiver of the caller notifies him that such is the case.

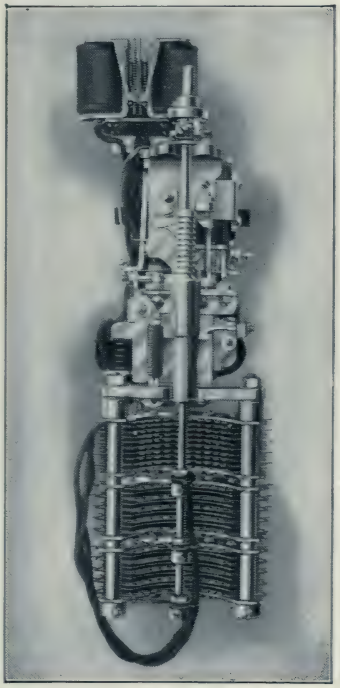
The keyboard or internal mechanism of the telephone, occupies a space 5x3x2 inches, and consists of an impulse-sending mechanism, which, in response to the rotations of the dial, communicates to the subscriber's switch a number of impulses corresponding to the number of the hole in which the finger is placed, lifting the shaft which occupies the central position of the switch, up to the proper row of contacts, and bringing the "wiping fingers" fastened thereto into connection with the proper contact in that row.

It should be understood that, when the call is made, no impulses are sent over the line on the down movement of the dial, but on the return. This is arranged for the protection of the instrument against careless or hasty subscribers. The return of the dial is regulated by a governor which always insures proper speed.

The calling mechanism may be said to be perfect. It is simple, and works with remarkable accuracy, speed, and precision.

The Switch

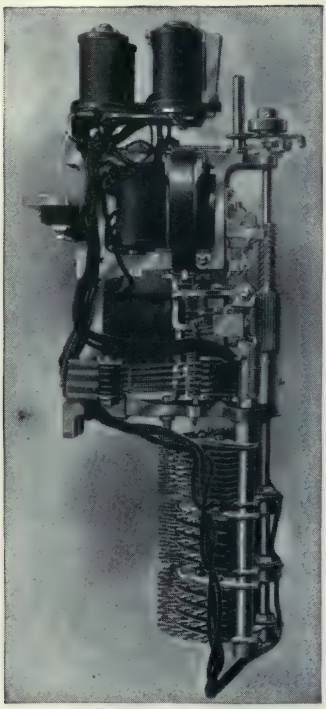
The switch, shown in the accompanying illustration, is a device about 13 inches in height, 4½ inches in depth, and 4 inches in breadth. The upper half of this device consists of two relays and



AUTOMATIC TELEPHONE SWITCH.
Front View.

three pairs of magnets mounted on a solid cast metal base. These relays and magnets, together with the proper springs, wires, etc., operate a vertical rod

in the center, in obedience to the impulses sent from the subscriber's telephone, and bring the three pairs of "wiping fingers" attached thereto into connection with the



Automatic Telephone Switch.
Side View.

brass contacts, which, arranged in three semicircular banks, constitute the lower half of the switch.

The upper of these banks, known as the "busy bank" serves to indicate busy lines in the automatic selection of trunks. The lower two are "line banks," to which the line wires connect, and over which the conversation is held.

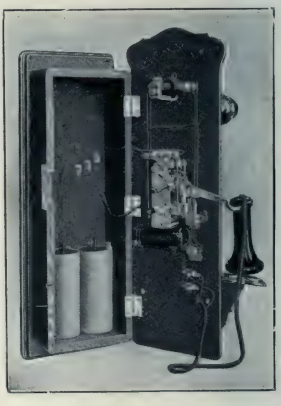
Two classes of switches are employed, one known as "selectors," of which there is one for every telephone connected with the exchange, and the other as "connectors," of which there are ten for every hundred selectors and which are in groups each capable of connecting one hundred telephones. The function of the selector is to connect the calling telephone with the connector in the proper group, which in turn connects with the telephone desired in that group. This is the case in exchanges of one thousand capacity or less. In larger exchanges a second collector is employed. This is an intermediate switch, and divides the work of selection with the first selector.

Trunk-Selecting System

The trunking system employed is very much akin to that now generally used in manual practice and, therefore, needs no description here. It may be said, however, that the selection of trunks is automatically accomplished, the "wiping fingers" on the shaft of the selector switch passing over all busy contacts and stopping at the first idle point.

Accessories

The accessorial equipment consists of a 52-volt storage battery, which furnishes the current for operating the switches; a cross-connecting board or distributing rack, equipped with carbon lightning arresters and heat protectors; a ringing machine with "busy back" and "howler"



Interior of Wall Telephone.

attachment; charging machines; power board, on which are mounted the usual knife switches, circuit-breakers, voltmeters, ammeters, etc., necessary for

controlling and measuring the current; and a "tell-tale" board.

This last consists of a number of 8-candle-power lamps mounted on a marble panel, together with a magneto bell. In case of a short circuit or "ground" on any line, the bell rings and the lamp on the panel glows. The position of this lamp instantly indicates to the attendant the exact location of the trouble, and oftimes enables him to rectify it before the subscriber is aware that there has been any trouble.

The automatic switches are mounted on steel shelves, twenty-five to the shelf, each board containing four shelves of first selectors, and one shelf of connector switches. This is the arrangement for a system of 1,000 stations. In a 10,000-station system, the board is made up of six shelves, four of first selectors, one of second selectors, and one of connector switches. The floor space occupied by such a switchboard is 11 feet 6 inches by 12 inches. The switchboard is made of steel angles and is rigidly braced.

A very important feature of the automatic switchboard is that it can be increased to any capacity by simply adding new sections with the desired number of switches mounted thereon, without in any way interfering with existing conditions. Ninety-five per cent of the electric contacts and connections are made at the factory; consequently better results are secured, as well as time and expense saved in installation.

Advantages of the Automatic System

1. A switchboard has no operators; and thus one of the large fixed charges incident to manual-exchange operation is eliminated.

2. There being no operators, the automatic exchange can be located in less expensive quarters than the manual. No reading or retiring rooms are needed, no lockers, no lavatories; and the cost of fuel and lighting is reduced.

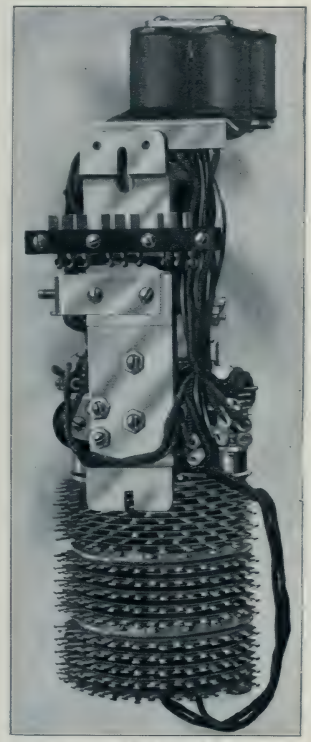
3. One switchboard attendant, for testing and keeping apparatus in order for 1,000 subscribers, is all that is needed in the automatic practice.

4. The cost of maintenance and interior equipment is no greater, and in large exchanges is less than in the manual exchange.

5. The service which the automatic system gives, unlike that of the manual system, is absolutely secret, each subscriber having a "private wire" on which to transmit his communication—an advantage that cannot be overestimated by the general business man, as well as by the broker, the lawyer, and the physician.

6. The subscriber himself instantaneously connects with the person he wishes to call; and the apparatus is so constructed that it is an impossibility for another subscriber to "cut in" or in any way interfere with the line he is using.

7. The frequent delays and mistakes which the manual board causes are entirely unknown to users of automatic telephones. The switches



AUTOMATIC TELEPHONE SWITCH.
Rear View.

do not make errors nor gossip; are never weary or sleepy; are not interested in subscribers' affairs; and are not impudent.

8. The complexity of the automatic exchange does not increase proportionately to the increase of size, as is the case with manual exchanges, where the cost of giving service is much more per subscriber in large than in small exchanges. The cost of operation in the automatic exchange is fixed. An increase is merely a matter of adding new telephones and switches, the cost of operation being the same per subscriber.

9. The automatic switch is thoroughly cosmopolitan in its nature, no interpreter being needed by the foreigner in a country where the automatic exchange is located, any person being able to secure the desired connection by simple rotations of the dial.

10. The same number of automatic switches are always at work, night and day.

11. Quick connections, instantaneous accommodations, prompt answers, accuracy, and promptness, with the busy signal given when subscriber called is busy.

Life Under Water

A Night's Experience on a Holland Submarine

SINCE the new Holland submarine torpedo-boat, the *Fulton,* spent a comfortable night on the bottom of Narragansett Bay, the public have felt that Jules Verne and his fabled *Nautilus* are a good deal of a reality.

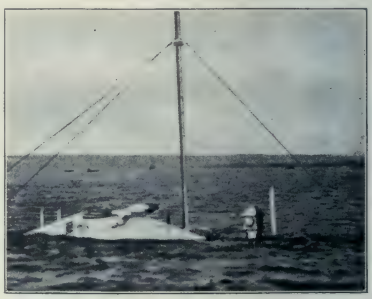
On the evening following the speed and fire tests, the Board of Inspection appointed by the Navy Department decided to test the *Fulton* as to the comfort of the men who had to live in her. It was therefore decided that the boat should spend the night at the bottom of the bay.

This was the first test ever made under naval supervision, to determine whether men can live aboard a submarine boat under water as safely as on the surface.

All the necessary preparations were made, and at seventeen minutes to eleven, the *Fulton* sank with nine men aboard.

One of the features of the crew's experience was the distinctness with which sound was conveyed under water. Early in the morning the submerged crew were awakened by what was afterwards explained to be the Fall River steamer touching at Newport on its way from New York. Although the steamer did not pass within a mile of the submerged *Fulton,* several of the crew of the submarine were awakened by her plowing through the water.

Before retiring for the night, the crew had an excellent supper. The cooking, as well as the lighting, was done by electricity. The air reservoirs were filled to their full capacity of 40 cubic feet; and when the *Fulton* rose to the surface in the morning, after being under water for twelve hours and twenty-three minutes, there was hardly a perceptible difference between the air of the submerged boat and that of the outside world.



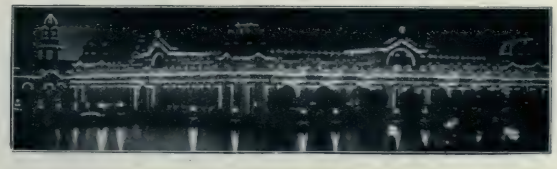
A Submarine in the Act of Submergence to Attack a Battleship.

A scene at the recent British naval manœuvers.

A novel experience occurred during the morning, before the boat rose to the surface. Lieutenant Nelson noticed a peculiar sound, as if the boat were scraping the bottom of the bay. Gazing through the glass of the conning tower,

he was astonished to see that the *Fulton* was besieged by shoals of fish, many of them four and five feet long. The larger of these fish were equipped with bills resembling a flattened spoon, and it was evidently the contact of these bills rubbing against the sides of the vessel that caused the very peculiar scraping sound.

It is interesting to note that the tests of the *Fulton* have been so successful that the Board of Inspection and Survey will recommend the expenditure of $850,000 for submarine boats of this type.



Practical Circuit Testing

By E. S. LINCOLN

Student, American School of Correspondence

THERE ARE TIMES when electricians are called upon to locate faults in bell and gas-light circuits, and will spend much time in trying to find the trouble. Everything will appear to be in good condition; but the batteries do not last long and finally give out entirely.

The reason for this nuisance, nine times out of ten, is found in a small leakage of current, which may be detected by means of a sensitive telephone receiver. Of course the leak cannot be located by the receiver; but if the electrician knows that there is a leak, he can find out where it is, being careful to examine fixtures, piping, damp places, etc., where the wires are run.

Electric Gas-Lighting Circuits

Referring to the sketch of the first test (Fig. 1), the receiver is connected to the points A and B; then the connection is made as indicated in the sketch of the second test (Fig. 2); and a comparison of the two sounds, made in the receiver at the time of connection, is taken. This comparison will give an idea as to the amount of leakage, if any exists. If there is no difference in the two sounds a short circuit is the cause; and if no noise is heard at all, the circuit is in good condition, provided that the wires are not broken.

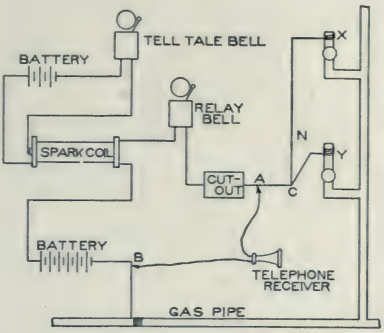


FIG. 1. FIRST TEST.

The above tests and connections (Figs. 1 and 2) are for electric gas-lighting circuits. All the apparatus shown in Fig. 1 is not necessary, but is shown so as to locate the connection A, which should be made on the burner wire after passing

through all apparatus, such as spark coil, bell, etc. In Fig. 2, or the second test, the cut-out, bell, etc., are left out.

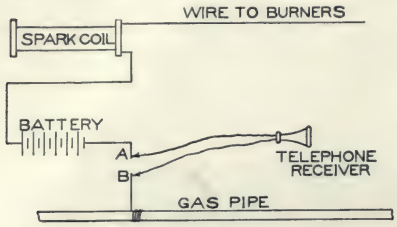


Fig. 2. Second Test.

If the spark coil is fitted with a circuit-closing attachment, as shown on the left-hand end of the coil in Fig. 1, it is not to be interfered with in any way when making the tests.

Where each burner is connected to a separate wire, as it should be, the trouble can easily be found by testing each wire. When the defective wire is found, it is cut out of the circuit and the other wires allowed to work again. Then go to all the burners and find out which one does

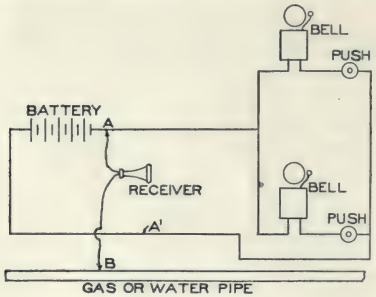


Fig. 3. Ground Test.

not work, and very likely the trouble will be found on the burner or jet. After the burner has been fixed, it can be put into service again by connecting its wire to the circuit of the battery.

To make this clearer, refer to Fig. 1, in which C is the terminal of the separate burner wires. Now suppose that the burner X is short-circuited, and that the burner Y is all right. The wires from the burners X and Y, which are connected at C to the battery circuit, would be separated, and the receiver terminals connected to the circuit wire A and the burner wire X at N. At the time of connection and disconnection, a click would be heard; and, as the wire is defective, it is cut out of the circuit, while the other wire from the burner Y, which is not short-circuited, is connected to the wire A. Upon examining the burners, it will be found that burner X is out of order; and when repaired its wire N can be connected to wire A at C again, and everything will work all right.

Electric Bell Circuits

Fig. 3 shows a method for detecting grounds in bell circuits or circuits where the ground is not used. If a click is heard in the receiver when the connection A B is made, there is a ground on the wire A'; and when the connection is made at A' B and the click is heard, the wire A is grounded. The contact be-

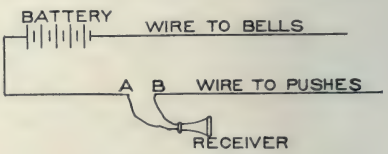


Fig. 4. Circuit Test.

tween the gas pipe and the receiver terminal must be very good.

Fig. 4 simply shows the connection for testing a bell circuit for leakage.

It very often happens that an electrician is alone when repairing or installing electric bells, and he cannot tell whether the bell rings or not when the contact is made; but, by using the telephone receiver, it is possible to tell just what the bell is doing when the button is pushed. Place the terminals of the telephone receiver on the contacts of the push button, and press the button several times. If a buzzing sound is heard when the contact is broken, the bell rings all right, provided that the hammer is properly adjusted. If no sound is heard at all, the circuit is broken; and if only a clicking noise is heard, the bell is not properly adjusted, or the batteries are not sufficiently strong to ring the bell.

There are a great many other uses to which the telephone receiver can be put, and one of these instruments should be in the hands of every electrician engaged in this class of work.

UNIVERSITY COLLEGE, MAIN BUILDING OF THE UNIVERSITY OF TORONTO.

View from the east. In the foreground is the Soldiers' Monument, in Queen's Park, just outside the University grounds, commemorating volunteers who fell in the Fenian Raid of 1866.

Great Technical Schools

The University of Toronto, Toronto, Ontario, Canada

By H. H. LANGTON, B. A.
Librarian.

THE LEADING UNIVERSITY of the Province of Ontario, the University of Toronto, is a State institution, which, originally organized in 1843, has since been remodeled three times—in 1849, in 1853, and in 1887. As early as 1798 an endowment of Crown lands for higher education in the province had been created, and in 1827 a charter was granted for the establishment of a university; but various difficulties remained to be overcome, and it was not until 1843 that a building had been secured, professors installed in the Faculties of Arts, Medicine, Law, and Divinity, and the work of teaching begun.

King's College

Not the least of the difficulties that postponed for sixteen years the actual organization of the University, had been the opposition of the Methodist and

Presbyterian bodies to the charter, which had been obtained through the exertions of the Rev. Dr. Strachan, a masterful divine of the Church of England, and which was found to restrict to clergymen of that Church the right to occupy chairs in the University, besides erecting a Faculty of Divinity for the exclusive advantage of the same communion. Before the actual organization in 1843 of King's College, as the University was

University of Toronto

The expectations entertained by the authors of this renovation of the State University were, unfortunately, not fulfilled. The denominational colleges showed no inclination to be absorbed; in fact, their number was increased by the foundation of a strictly Anglican institution—Trinity College—which owed its being to the indefatigable Bishop Strachan. For four years the new Uni-

UNIVERSITY COLLEGE, FROM THE SOUTH.

then called, certain amendments to the charter were made in deference to public opinion, abolishing religious tests; but the control of the institution still remained in the hands of Doctor (now Bishop) Strachan and his friends, and for six years it was conducted under Church of England auspices. Meanwhile the Methodist and Presbyterian bodies had established rival collegiate institutions of their own, while not ceasing to agitate politically against the sectarian character of the State University. In 1849 their agitation bore fruit. The Faculty of Divinity was abolished, a larger measure of public control was instituted, and provision was made for the affiliation of denominational colleges. At the same time the name was changed to that which has ever since been retained —the University of Toronto.

versity of Toronto waited for the ingathering of the denominational colleges. In 1853, however, in default of any movement in that direction—and, indeed, in consequence of the continued opposition and hostility of these colleges and the denominations which supported them —the Legislature saw fit to change its constitution again. The time was not yet ripe for a comprehensive system of higher education under State control and with State assistance. The Faculty of Medicine was regarded as an unfair invasion by the Government of the field of private enterprise in favor of a single profession, and it was decided to abandon the teaching of medicine to proprietary schools. The Faculty of Law also was dropped; and the Faculty of Arts, the only one remaining of the original four under the charter of 1827, was

reconstituted as University College, a teaching institution, while the University itself became a mere examining and degree-conferring corporation like the first University of London.

University College

For more than thirty years the requirements of the Province were sufficiently met by the provincial institution with its single Faculty, and by the rival denominational colleges and private institutions. But the rapid advances of education in science imported a new factor into the situation. The University of Toronto and its teaching Faculty, University College, gradually introduced into ordinary undergraduate courses practical laboratory instruction in biology and physics, and increased the facilities for experimental work in chemistry and mineralogy. The cost of maintaining these departments threatened to exceed the resources of the institution, and the growing expense of teaching the scientific subjects pressed even more severely upon its rivals. A federation of universities in the Province—which had been more or less a dream for nearly forty years—became a practical question. One of the denominational colleges was now ready to amalgamate with the State institution, and the others were considering a similar renunciation of their university privileges. In 1887 the University was again reorganized to suit the new conditions of higher education in the Province. The departments of instruction in Arts were divided, speaking roughly, into "literary" and "scientific." The former were assigned concurrently to University College and to such denominational institutions as should enter into the federation. The scientific departments were the portion of a newly created Faculty of Arts in the University, instruction in these subjects being common to students of all the colleges, including University College. Teaching Faculties of Medicine and Law in the University were also reestablished. The results of this arrangement have fully justified the change. Victoria College, the Methodist institution, and Trinity College, that of the Church of England body, have cast in their lot with the University of Toronto, thus constituting, with University College, a group of colleges engaged in friendly rivalry in the teaching of the literary subjects of an Arts course. The new Faculty of Arts of the University, composed of the scientific departments, has received great accession of strength, both from the attendance of students formerly educated entirely by the denominational colleges, and also from the establishment of the sister Faculty of Medicine. The teaching in Medicine has been deepened and broadened by basing professional training upon a more intimate acquaintance with the sciences of biology and chemistry than had been possible in the days of proprietary schools. A later addition to the Uni-

MAIN UNIVERSITY BUILDING, FROM THE NORTH.

versity was the Faculty of Applied Science, which will presently be described in detail. The original endowment of the University proving insufficient, liberal additions have been made in recent years by the provincial Government, both in the form of grants of money and lands and by the erection out of public funds of new buildings.

The great expansion of the University of Toronto in the period since the federation movement began, can perhaps be best appreciated by a statistical comparison:

In 1885 a single building contained the Convocation Hall, the Library, the Natural History museums, besides all the lecture rooms, laboratories, offices and private rooms of the staff, except that the Chemical Laboratory and lecture room and the Biological and Mineralogical Laboratories were temporarily accommodated in the School of Practical Science, a provincial institution in which the University College professors also gave instruction. In 1904 the old University building has been enlarged, and there are new separate buildings for Chemistry, for Biology (including the Biological Museum), and for the Library. A building for Geology, Mineralogy, and Mining Engineering is in course of erection; a Convocation Hall is begun; plans for a Physics building are in preparation; a Medical building and an Applied Science building, representing two new Faculties, also form now a part of the University. Again, in 1885, the staff of teachers in Arts subjects was fifteen in number. In 1904 they number seventy-three, without reckoning those in the federated colleges—Victoria, Trinity. In 1885 there were 366 students in Arts attending lectures. In 1904 there are 1,012 students in Arts, 721 in Medicine, 402 in Applied Science.

BIRD'S-EYE VIEW FROM TOWER OF MAIN UNIVERSITY BUILDING.

Looking Southeast, showing Library, Medical Building, and School of Practical Science, from left to right across the Campus.

The Scientific Courses

The scientific instruction in the University of Toronto is conducted in the main University building, where the Physical Laboratories are at present situated; in the Medical building; in the Chemical building; in the Biological building; and in the School of Practical Science, which is devoted mainly to Engineering. The Mining building, now approaching completion, will also house the Mineralogical and Geological Departments and that of Applied and Electro-Chemistry. The regular honor courses in Physics, Chemistry, Geology and Mineralogy, and Biology, lead to the degree of Bachelor of Arts, and extend over the usual period of four years, in each of which practical work in the laboratories is prescribed. Other subjects of a general education are required in every year; and special importance is attached to facility in reading French and German, on account of the necessity for a knowledge of these languages on the part of anyone who intends to follow the progress of scientific research. After graduation in Arts, students who have

successfully pursued an honor course in any of the above sciences may enter upon a further two years' course of original investigation, which leads to the degree of Doctor of Philosophy.

Department of Physics

The Physical Department at present, as already mentioned, occupies one wing of the main University building; but the accommodation there is proving insufficient, and steps have been taken for the erection of a separate building, exclusively for Physics, which, it is expected, will soon be commenced by the authority of the provincial Government. In the honor course in Physics, leading to a B. A. degree, the laboratory instruction of the first two years covers all the work of a general course in physics. In the third year, special subjects for experiments are taken up; and students are given practice in the use of laboratory instruments, photography, lathe work, glass blowing, soldering, silvering, and other means of making and repairing apparatus. In his fourth year the student is now sufficiently familiar with the use of all the instruments and appliances to be capable of entering upon some piece of research. He is encouraged to spend as much time as possible in laboratory work, and to study the methods of research and the successive steps of scientific discovery as recorded in the English, American, and foreign journals of physical science. If he displays special aptitude, he is set to work at some new investigation. There are a series of elementary laboratories for students of the lower years, and special laboratories in heat, acoustics, optics, and electricity, besides a well-equipped workshop in charge of a mechanician, where most of the apparatus needed for research can be constructed. All necessary instruments for experiments and original work are in the laboratories, the collection of acoustical instruments being especially complete, including, as it does, all the best instruments manufactured by Dr. Koenig.

CHEMICAL BUILDING.

Department of Chemistry

The Chemical Department has occupied its own building since 1895. In it all branches of the science except applied chemistry are taught, and about 400 students are engaged in laboratory work. The larger of its two lecture rooms will accommodate 300 students, and the laboratories contain upwards of 200 working places. There are separate laboratories for qualitative analysis, quantitative analysis, organic preparations, physical

BIOLOGICAL BUILDING, EAST WING.

chemistry, gas analysis, combustion and furnace operations, besides a number of special private laboratories for original investigation. The Laboratory of Physical Chemistry is one of the six largest on the continent of America. Original papers to the number of sixteen, by members of the staff and students engaged in research, were published during the year 1903.

Department of Biology

The Biological Department was the first of the departments of science to obtain accommodation in a separate building with all the modern equipment of laboratories and appliances for experimental work. The building dates from 1889. The central portion is occupied by a Museum consisting of four large rooms, seventy-five feet in length. Three of these rooms are assigned to Animal Biology; while the fourth, which will be arranged for the illustration of Vegetable Biology, is temporarily occupied by the mineralogical collections. Of the two wings of the Biological building, one is devoted to anatomical work in connection with the instruction in the Faculty of Medicine; the other contains the rooms and laboratories of the Biological Department proper. There are lecture rooms, the largest capable of accommodating 250 students; elementary laboratories; advanced laboratories, for third year and fourth year students, for vegetable physiology and bacteriology; a library of the principal biological periodicals; a photographic room; a drafting room, for preparation of diagrams; hothouses, for use in connection with practical courses in botany; an aquarium; and rooms for the preparation of museum specimens. The laboratories of animal physiology, six in number, are contained in the Medical building.

Department of Mineralogy and Geology

The Mineralogical Department is at present occupying temporary quarters in the Biological building and School of Practical Science. In the new Mining building it will receive ample accommodation, laboratories being provided capable of accommodating 100 students working at one time, besides special rooms for research work.

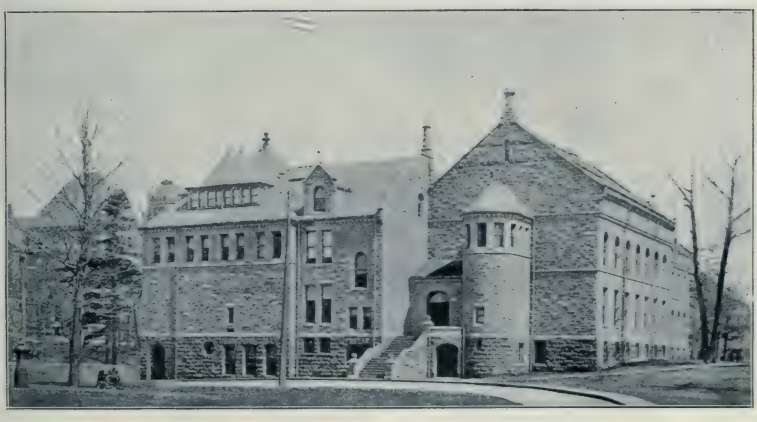
School of Practical Science

The School of Practical Science, which contains the laboratories and appliances for the teaching of Engineering in all its branches and of Analytical and Applied Chemistry, was originally an independent institution, founded in 1877. It was affiliated with the University of Toronto in 1889, and in 1900 the whole

staff was constituted the Faculty of Applied Science and Engineering of the University. At the same time provision was made for the extension of the new Faculty by the erection of a new building to accommodate the instruction in Applied Chemistry, Metallurgy, Assaying, Mineralogy, Geology, and Mining. When the new building is completed, the present one will be entirely given over to the Engineering Departments and to Architecture.

There are six regular departments of instruction in the School: 1. Civil Engineering; 2. Mining Engineering; 3. Mechanical and Electrical Engineering (subdivided into two graduating departments in the third year); 4. Architecture; 5. Analytical and Applied Chemistry; 6. Chemical Engineering.

In two respects the course of study is different from that in vogue at most technical schools: there are *no culture subjects* and there is *no shop work*. The student seeking admission must have already passed the University Matriculation in Arts or an equivalent examination, and no further attempt is made to add to his stock of general information. He becomes at once a professional student. Shop work is also omitted from the course in Engineering subjects, since it is considered that the practical lessons to be learned in shops are more effectively learned in commercial works than in a school of applied science. Moreover, shop work is held to be an interruption to the real educational work, which is to give a thorough knowledge of scientific principles underlying the practice in the professions, together with such laboratory and experimental practice as is essential for the proper understanding of those principles. By leaving out culture subjects and shop work, is has been found possible to give students a complete education on the scientific side of their future professions in three years, at the end of which time the ordinary course of study is complete and a diploma is issued, which is recognized throughout the country as a qualification for professional employment. In the Department of Mechanical and Electrical Engineering, however, the diploma is withheld until certificates of twelve months' work in manufacturing shops are produced. The shop work thus required of students in these branches of engineering is entirely outside the School course of instruction; it may be done during vacations, or postponed until the full three years of lectures and examinations have been completed. Vacation work is required of all students. It takes the form of a thesis on some practical subject to be selected from several prescribed, and of notes on construction, which must exceed a certain minimum quantity.



BIOLOGICAL BUILDING.
Museum and West Wing.

The University degree of Bachelor of Applied Science is conferred only after a fourth or postgraduate year of study in the School. In contradistinction to the work of the regular three years' course, which covers the whole field of scientific training applicable to each department of Engineering or Applied Chemistry, the fourth year is one of specialization. Not more than three subjects may be taken up, and in these great stress is laid upon experimental investigation. The student is expected to spend the greater part of his time in the laboratory, and the hours for advanced theoretical instruction are arranged so as to leave uninterrupted periods for lengthy experimental processes.

Higher degrees in the four branches of Engineering—Civil, Mechanical, Electrical, and Mining—are also conferred by the University; but these are strictly professional honors, no candidate being eligible who has not served at his profession for three years since obtaining the degree of Bachelor of Applied Science. The examination is limited wholly to the professional side of engineering work in the branch selected, in contradistinction to the examination for the degree of Bachelor of Applied Science, which was confined to the mathematical and scientific side. The examiners for the degrees in Engineering are professional men.

The Engineering Laboratories are equipped with the best available machines for experimental purposes. The Steam Engine Laboratory contains a Babcock & Wilcox 52-H. P. boiler; a Harrison-Wharton 12-H. P. boiler; a 50-H. P. Brown engine, specially constructed for experimental investigations, steam jacketed, and with three alternative exhausts—to the open air, to a jet condenser, and to a Wheeler surface condenser. There are also a Blake circulating pump, a Knowles feed pump, a Blake feed pump, and the usual measuring instruments.

SCHOOL OF PRACTICAL SCIENCE.

In the Hydraulic Laboratory there are two large steel tanks arranged for experimental study of the flow of water through orifices and over weirs; the water is supplied by a three-throw pump with double-acting cylinders, having a capacity of 500,000 gallons per 24 hours. There are also various turbines, two cen-

trifugal pumps, a Venturi meter, and other apparatus for measuring discharge and frictional losses.

The Strength of Materials Laboratory contains an Emery 50-ton machine and a Riehle 100-ton machine for making tests in tension, compression, shearing, and cross-breaking. The latter will take in posts twelve feet long and beams eighteen feet long. There are also a Riehle 10-ton universal testing machine; an Olson torsion machine, capable of twisting shafts sixteen feet in length and two inches in diameter; a Riehle transverse testing machine; a Riehle abrasion machine; and various types of extensometers and micrometers.

The Electrical Laboratories are supplied with power by means of a 20-kilowatt Edison motor, which drives several continuous-current dynamos, series-, shunt-, and compound-wound, bipolar and multipolar, a Westinghouse experimental alternator, and a rotary converter when used as a polyphase dynamo. There are also a Crocker-Wheeler direct-current motor and a 6-H. P. Edison motor, used in the mill-room but available for testing, besides fan motors. Of alternating-current motors, there are a three-phase and two single-phase induction motors; a special experimental poly-

NEW BUILDING FOR DEPARTMENTS OF MINERALOGY, GEOLOGY, MINING, AND APPLIED CHEMISTRY.

The Cement-Testing Laboratory is fitted with the usual moulds and gravimeters; and contains also a Riehle 2,000-pound machine for either tension or compression, another smaller Riehle machine for tension only, and an extra large Faija's hot bath apparatus. In the Metrological Laboratory there are 100-foot and 66-foot standards of length, a 10-foot Rogers comparator with graduating attachment, a Kater's pendulum with vacuum chamber, a Howard astronomical clock and electro-chronograph, a sidereal chronometer, theodolites and other necessary field instruments.

phase induction motor of 7½ H. P., in which the rotor terminals are all separately accessible; and a constant-current transformer with a series of six arc lamps. The galvanometer room has ten masonry piers to support instruments in such a way as to be free from vibration. In the Laboratory for Advanced Work there is a Kelvin balance and its rheostat, and an enclosure for experiments with high voltages. A first-rate collection of instruments, too numerous to particularize here, is one of the features of the laboratory equipment.

The Laboratories of Applied Chemistry and Assaying, as well as the mill-room, will, in the course of a year, be removed to the new building now approaching completion. In their present quarters they contain all the necessary equipment, but the space accommodation is limited. The present mill-room contains a plant by which a complete mill test can be made of more than a ton of ordinary mill ore, the machinery being all of the same construction as that employed in the best large mills. There are also leaching vats for treating ores by the cyanide process, and a chlorination barrel. It is too soon to describe the improved equipment that the Mining Department will have in the new building, but no doubt it will be worthy of the edifice in which it is housed and of the University in whose youngest Faculty it will form a most important branch.

Largest Graving Dock in the World

A Description of the Immense New Dry Dock at Southampton, England, Now Building for the London & Southwestern Railway

By WINTHROP PACKARD

THE NEW GRAVING DOCK now being constructed for the London & Southwestern Railway Company at Southampton will be the largest of six dry docks belonging to the company, all of which are in constant use. About eight years ago a somewhat smaller dock—but then the largest in the world—was opened by His Majesty the King (then Prince of Wales). Since that time the size and number of vessels frequenting the port of Southampton have been steadily increasing, and it has become necessary to provide more dry-dock accommodation for vessels of the largest class. Accordingly, towards the end of 1899, the directors of the railway company instructed their consulting engineer, Mr. W. R. Galbraith, M. Inst. C. E., to prepare designs for the present work, the contract for which was let to Messrs. John Aird & Company early in 1901.

The dock will be approached by vessels directly from the estuary of the River Test, which forms one boundary of the company's estate. The river channel has been deepened by dredging to 30 feet below L. W. O. S. T., thus forming an ample approach. The dock itself will be 860 feet long (clear inside gates), with

S. S. "PHILADELPHIA" IN PRINCE OF WALES DRY DOCK, SOUTHAMPTON, HAVING HER BOTTOM PAINTED.

provision for extension if necessary; 90 feet wide at entrance, with the same bottom width inside; and 125 feet wide at cope level. The whole depth from cope

PRINCE OF WALES DRY DOCK, SOUTHAMPTON, ENGLAND.

One of the Largest Graving Docks in the World.

to floor will be 43 feet, giving a flotation depth over keel-blocks of from 29 feet 6 inches, neap tides, to 33 feet, spring tides, at high water.

It is built almost entirely of Portland cement concrete, the floor, altars, and walls being faced with this material. The cement is supplied from the Thames and Medway districts, and an excellent gravel is dredged from Southampton Water, quite near the works. The bulk of the concrete is mixed in the proportion of 8 parts to 1, the facing to walls and floor, together with the culvert linings, being somewhat stronger, generally 4 to 1. A skin of 4 to 1 concrete is also laid on the under side of the floor, and carried up the back of the walls, so as to prevent any water which may accumulate there from soaking through the more porous concrete into the dock. This 4 to 1 concrete is made with special care, the large stones in the gravel being reduced in a steam crusher.

The hollow quoins and cill quoins against which the dock gates close, are of granite from the Shap Quarries in Westmoreland. The steps and timber slides are also faced with this stone.

The walls are 22½ feet thick at the base, diminishing to 3 feet at the coping level. The floor is flat on its upper surface, but is so constructed on its under

Work Going on in New Graving Dock at Southampton

side that it is no less than 16 feet thick at the center of the dock. Such a massive floor might at first sight seem unneces-

A GLIMPSE OF THE WATER-FRONT AT SOUTHAMPTON.

View showing Empress Dock, and S. S. *ST. PAUL* in her berth.

sary, seeing that it rests on solid ground; but it must be borne in mind that, besides supporting the weight of a vessel, the floor has to be strong enough to shut out the underground water, which is everywhere struggling to force its way into the dock, under enormous pressure.

The altars, seven in number, are all grouped near the top. They are 2 feet 6 inches wide, and only 2 feet 9 inches

END VIEW OF NEW GRAVING DOCK, SOUTHAMPTON.

View taken during progress of construction.

high, being thus very safe and convenient to work on. Access to the floor is given by eight flights of steps, and four slides for timbers are provided.

The entrance gates are being constructed by Messrs. Head, Wrightson & Company, of Teesdale. They are built of steel with greenheart meeting faces, and weigh some 250 tons per leaf. They will be opened and closed by direct-acting hydraulic rams—a somewhat novel principle. The rams are being made by Messrs. Armstrong, of Newcastle.

For emptying the dock, the water will fall into six large pits near the entrance. From these. three tunnels will lead it to the pump wells, which are placed behind the eastern wall and at a level of 10 feet below the dock floor. Over these an engine house is being built, to contain two 48-inch centrifugal pumps, made by Messrs. Gwynne, of Hammersmith. The

CEMENT MIXER AT WORK.

pumps will be driven by direct-acting vertical steam engines, steam being supplied from a battery of seven boilers, of the locomotive type, in an adjoining building. This plant is designed to empty the dock in 2½ hours if required.

The dock will be fitted with every modern appliance for convenient working. Notably, a traveling electric crane is being built for it by Messrs Stothert & Pitt, of Bath, to lift no less than 50 tons at 80-foot radius.

Two years ago the site of the docks was nothing but a mudland, covered by the river water at every high tide. The first thing needed was to reclaim the land; and this was done by tipping a horseshoe bank of chalk around the site. This bank was covered with clay to make it water-tight, and pitched with stone to strengthen it. From the enclosure thus

S. S. "OCEANIC" IN LIVERPOOL'S LARGEST GRAVING DOCK.

formed, the water was thrown out by two pumps, which still work day and night to keep the works dry and safe. Excavation by hand and by "steam navvy" was next on the programme; and this was carried down as low as seemed safe. Heavily timbered trenches were then sunk along each side of the dock, and in these the massive concrete walls were built. It now remained only to excavate between the walls and build the huge dock floor. This work is being rapidly pushed forward to completion, piece by piece.

The chief engineer is Mr. W. R. Galbraith. M. Inst. C. E.; and the resident engineer is Mr. F. E. Wentworth-Sheilds, Assoc. M. Inst. C. E. The contractors, Messrs. John Aird & Company, are represented at Southampton by Mr. J. W. Landrey.

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EDITORS { WILLIAM A. COLLEDGE, D. D.
ALFRED S. JOHNSON, PH. D.
CARL S. DOW, S. B.
RUTLEDGE RUTHERFORD

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¶ Economy is half the struggle.

¶ One does not have to wait to be fleeced to prove that he is not a wolf.

¶ The less we speak of our personal virtues, the more conspicuous they appear.

¶ A happy, smiling, cheery face pays much of the fare in the journey of life.

¶ Many a man would be rich if he did not try so hard to appear to be.

¶ The value of a man's principles depends on what it costs him to cash them in practice.

¶ It's a good deal easier to sit up straight in church than it is to walk upright in the world.

¶ The editor would sometimes like to be a barber. He might then get in all the cuts he wanted.

¶ There is a great deal of broken English in this country to-day. The "ten commandments" are referred to particularly.

¶ Take a lesson from this: It is the steady-gaited horse that covers the greatest number of miles in a day with the least effort.

¶ A little smile to-day may be worth the most eloquent funeral sermon to-morrow.

¶ There are always two sides to an argument, but either side is much less than half of it.

¶ If people would make more of their own business, and quit minding that which is none of their business, their own business would be more prosperous.

The Forestry Movement

THAT trees make the weather, is a scientific truth impressed upon us each year by the alternating procession of disastrous freshets and parching drouth to which large areas of our plains and river valleys are exposed with periodic regularity. Now and then a railroad wreck, like that of the World's Fair flyer in Colorado, caused by the sudden rising of a mountain torrent, tolls its note of warning; but the lesson is as soon forgotten.

Mr. Mitchell's article opening this number, not only reveals the folly and danger of recklessly throwing aside the protective woodland mantle that Nature designed to cover the breast of Mother Earth, but gives an attractive picture of the possible results of reforestation, and calls special attention to the admirable work of the Forestry Bureau, which deserves the support of Congress and of all live, intelligent, and broad-minded citizens. A particularly significant passage is that which insists on the fact that there is no necessary antagonism of interests between the forester and the lumberman. "It is the essence of forestry to have trees harvested when they are ripe, and followed by successive crops." Thus, in the long run, even the selfish, material welfare of all will be best served through this eminently rational policy, not to speak of the reclamation of vast areas that now lie worse than fallow, or of far-reaching climatic effects that are essential to the conservation of some of the richest of our national resources.

It is not only in the United States that the evils of forest destruction can be

noted. A striking object-lesson is found in some of the northern states of Brazil, where, owing to the denudation of timber lands, the desolation of chronic drouth and torrefaction now reigns over vast regions that once offered every inducement to the settler. In the United States the waste of timber during the past fifty years has been almost beyond belief. The continental railroads alone destroyed millions of acres of forests. They slashed and burned recklessly in building their lines, and their engines set fire to and ruined vast areas. Settlers, with no thought of the future value of the timber, added heavily to the waste. And worst of all, the perambulating lumber camps, with a policy as short-sighted as it was avaricious, "cleaned up" untold wealth that lay so abundantly at hand. In one way or another, the ruthless hand of the destroyer has done damage that can be repaired only at the expense of many years. The work of the Forestry Bureau of the Government should be built up and strengthened by more stringent laws and more liberal appropriations.

Passing of the Telephone Girl

GOOD-BYE to the "hello girl!" Welcome the new era in telephony! The automatic or "girlless" telephone has come. Long-distance conversation by wire is now made nearly as simple a process as talking to a person in the same room with you. No waiting for connections to be made, no mistaking of numbers, no aggravations of a hundred other kinds born of human imperfection. The automatic telephone cannot err, any more than figures lie. Just turn the indicator to the respective digits of the number you want, and the automatic system does the rest. Instantly it rings the bell at the other end, and conversation may be begun without further delay.

Of course all of us will miss the telephone girl's sweet voice with its often-practiced rising inflection, and we should be grieved to think that so many of the "hello" sorosis would be thrown out of employment were it not for the belief that her position will thereby be bettered. The soft voice she has cultivated from the gentle "Hello," and "Number, please," and "They're talking, call again, please," is sure to stand her in good stead in finding a more satisfactory way of earning a livelihood. The life of the telephone girl was not the most delightful in the world, anyhow. Her hours were long, her labors toilsome and unhealthful. There never was a successful invention to economize labor that did not work to the benefit of all concerned who had the disposition and the desire to be benefited. Therefore we hope to see the telephone girl of yesterday holding a more exalted commercial position or dictating the duties of the household to-morrow.

The automatic telephone has already been installed in Chicago and many other cities. It will add to our convenience and contentment. It is called the "girlless," "noiseless," "waitless," "cussless" system.

Land Enough for All

"LAND WITHOUT POPULATION is a wilderness. Population without land is a mob." It was James J. Hill, the uncrowned king of the Northwest, who said this. Mr. Hill did much toward equalizing the conditions in his chosen domain, and thus aided the Northwest in becoming rich and powerful. But what a vast area of uncultivated land still remains in the United States awaiting but the population to make it an empire, and what a myriad of vain toilers there are in the overcrowded districts of the United States and Europe that need only land to become the makers of an empire. An empire greater than all of America's new possessions and greater than the present America itself can be reared from the untilled soil of the Western States. This is the grand work the Salvation Army has undertaken. Commander Booth Tucker tells about it in this issue of THE TECHNICAL WORLD, and his splendid mission is bound to appeal to every person interested in this country's welfare. It is one of the most important movements of the age. Probably there is no organization better capacitated to perform this

great work than the Salvation Army. Its toilers of the slums know well the millions of poverty-stricken inhabitants of the cities whose lives are worse than wasted in the urban struggle for a livelihood. Gather them in, and convert their wasted energies into the making of a nation, even as the wasted waters of the cataract are curbed to turn the wheels of commerce. This is what the Salvation Army strives to do. Under existing conditions this army of struggling city toilers cheapens labor by the mere fact of its superabundance of numbers and the resultant competition. Take them to the West; lessen the competition in the cities thereby; and produce from Mother Earth raw products to give more work to those who remain in the cities. This will enrich the laborer, better the condition of the manufacturer, and advance the whole nation commercially, morally, and intellectually. The soil, it should be remembered, is the source of all wealth. Instead of so many struggling for a share of the wealth now coming from the earth, would it not be better for more hands to go to work at digging more wealth from the earth, that there might be a greater amount of wealth to divide up among us all? That is exactly the idea that the great Salvationist had when he undertook his grand task. It is a scheme of economy that has no equal at the present time in our country. It is a philanthropic undertaking that is more commendable than giving away fortunes, for it helps the man to help himself, and that is the only substantial aid that can be given. It will make the idler a producer instead of a pauper, a creator of wealth instead of a parasite. Commander Booth Tucker's efforts are deserving of the encouragement and substantial aid of every charitable and philanthropic organization in the United States, and in fact every man and woman who has the country's and humanity's interests at heart.

The Submarine Mine

A CONCUSSION of the sea like the explosion of a submarine volcano; a reeling, crashing of the vessel as it is hurled heavenward on the bursting waterspout; a whirlpool of seething, foaming brine and wreckage; a sea bestrown with dead and dying; a once powerful battleship sinking to the ocean's bed! This, and the little submarine observation mine has finished its single mission of destruction. The pressing of a button on shore did it all; and the operator of the mine with his glasses watched the havoc his simple performance had wrought while he himself was secure from danger, probably secluded in an underground room in an embankment overlooking the harbor. He had before him a diagram of the harbor, and in his hand spy-glasses with the aid of which he could peer through his peephole and watch the movements of the enemy's ships. On his diagram was marked the location of every string of mines; and when he noted a vessel approaching one of them, he placed his hand on the key and pressed it when the vessel was directly over the mine.

Thus the little submarine mine, manufactured at less cost than it takes to build an ordinary rapid-fire gun, had done more damage than probably a whole fleet of war vessels might do in a hard battle consuming tons of coal, wasting thousands of dollars worth of ammunition, and exposing the ships and men to the enemy's fire.

These things partially explain the prominence into which the mine has sprung since the beginning of the Eastern war. It has proved one of Japan's most effective weapons, and to its destructiveness Russia attributes the loss of many of her most powerful battleships. But Russia, too, has learned now to use the mine, and so the vessels of each nation are forced to carefully watch their path in the sea, especially when approaching a harbor.

The land mine, used with such success by the Russians in defending Port Arthur against the Japanese, is an extension of the idea embodied in the submarine mine; and it is believed that the success of mines in this war will greatly enhance their importance in the future armament of nations. Ports and forts will become impregnable from the belts of dangerous underwater and underground explosives surrounding them.

BIRD'S-EYE VIEW OF HADLEIGH COLONY, NEAR LONDON, ENGLAND.

A Typical Scene Illustrating the Magnificent Work of the Salvation Army.
The colony comprises a tract of 3,000 acres near the mouth of the River Thames.

The Landless Man to the Manless Land

Colonization Work of the Salvation Army in the United States

By COMMANDER FREDERICK BOOTH TUCKER

THE SYSTEMATIC COLONIZATION of the worthy poor upon the vast agricultural areas of this country, is probably the most important and interesting industrial question of the day, and contains in it the practical solution of many of our most difficult problems.

On the one hand we have an enormous territory, for which population is needed in the worst way possible. On the other hand, our national prosperity and the advance of civilization are being menaced by the aggregation of population at certain centers, where neither work, money, nor food can be obtained by them in sufficient quantity to meet their requirements.

Some years ago I said to our friends, let us take this waste labor and place it upon the waste land by means of waste capital, and thereby convert this trinity of waste into a unity of production. Or,

A COLONY COTTAGE, FORT AMITY, COLORADO.

in other words, as it has been tersely and admirably expressed—"Place the landless man upon the manless land."

MILKING TIME.

There were not wanting those who expressed their opinion that the people would not go, would not stay, would not work, and would not pay. To this I replied that the unwillingness of the population to respond to the call of "Back to the Land" was due to certain well-defined causes which required to be dealt with. Our urban population contains, it is true, a large number of people who have been born and bred in the city, and who prefer that character of life, who are not at present particularly fitted for an agricultural career. It also includes, however, a vast number of people who have migrated from the country to the city, and who are thoroughly acquainted with agricultural conditions.

This latter group, again, may be divided into those who prefer city life, and who are placed beyond the reach of want; while there is also a very large number of those who are driven to the city by pure force of circumstances, and who would gladly go back if a reasonable opportunity were furnished them.

Amongst the first class, also, we should add, there are many who are weary of the battle of life in the city, and who would embrace an opportunity of removing to the country, and of fitting themselves in the meanwhile for a future agricultural career by acquainting themselves and their children with practical farming. Hence I have no hesitation in saying that there are hundreds of thousands of people in our cities who would be thankful to settle upon the land and to make permanent homes for themselves.

It may be asked why, then, have not these people already availed themselves of the opportunities afforded under the provisions of the homestead laws, or why do they not go to work for farmers. I reply, there are two reasons: one, because they have families; and another, because they have no capital.

The fact that they have families makes it expensive, and in fact impossible, for them to move about in search of a suitable opening. Moreover, they are not wanted by the farmer, who is anxious to secure the services of the single man or the cowboy, as he can more easily turn them adrift when they are not required, and their support is less expensive.

Now, I venture to say that these family people without capital make the very best sort of colonists, and, under proper supervision and management, they can

A CORNER IN THE ORCHARD.
A Scene at Fort Romie, California.

be employed to great advantage in settling up our vast areas of vacant land. I am able to say this after a practical experience of some six years in dealing with this class of settler. We have now three colonies, including about 3,000 acres of land, with some 530 men, women, and children settled upon them. Out of an expenditure of some $300,000, about $45,000 has been repaid. Some of the colonists have paid for their land in full; others have more than kept up their installments; while others, again, are somewhat in arrears, but will ultimately work their way through.

We have, of course, been limited by the amount of capital at our disposal. The work is in no sense a charity, the colonists being charged for all the money expended upon them, and having to pay interest as well. It seems to me, however, that the time has now come when it should be taken up on a larger national basis. The Government of New Zealand has set an admirable example in this respect to the Governments of the world, having expended $18,000,000 under the Advances to Settlers Act during the last eight years. They have had no losses; there is $600,000 in their sinking fund; and a surplus of $340,000.

There is no reason whatever why our

ONE OF THE IRRIGATION CANALS AT THE POINT WHERE IT ENTERS FORT ROMIE COLONY.

Federal Government should not take up the question; and a bill embodying the same was introduced by Senator Hoar in Congress last March, and is now before the Senate Committee on Public Lands.

A COLONIST FAMILY IN THEIR STRAWBERRY PATCH.

During my recent visit to London I discussed the question with the Right Honorable Earl Grey and other leading statesmen, as to the possibility of introducing a similar measure in Great Britain with a view to the unification of the British Empire, and the establishment of colonies in South Africa, Australia, and Canada. My suggestion was that bonds should be issued for the purpose of making advances to desirable families, in the same way as has been done in New Zealand. I may mention that the British Chartered Company of South Africa, of which Earl Grey is Vice-President, is very desirous that the Salvation Army should assist in the colonization of Rhodesia, and plans are now under con-

THE COLONY ORCHESTRA, FORT ROMIE, CALIFORNIA.

sideration for the raising of the necessary capital for this purpose. The late Cecil Rhodes was himself greatly interested in the colonization work of the

COLONISTS BUILDING A COTTAGE.
Fort Amity Colony of the Salvation Army, Colorado.

Army, contributing to its funds, visiting our colony near the mouth of the Thames, and purchasing some of our prize poultry for his South African farm.

There is no reason at all why armies of colonists should not be marched ten

Some Colony Poultry.

thousand, twenty thousand, fifty thousand at a time, carefully selected, thoroughly prepared, trained for the object, and settled upon the land in happy, self-supporting communities. If for killing purposes the nations of the world are prepared to spend hundreds of millions of dollars in placing vast armies of men in the field, why should not a reasonable amount be expended in settling the worthy poor of our great cities under conditions which will make them into

Ruins of Hadleigh Castle.
Situated on the land of the Hadleigh Industrial Colony, near London.

happy, self-respecting, home-owning citizens, who shall furnish strength and stability to the institutions of our country? I am sure that this can be done on a scientific basis, which shall absolutely secure a reasonable return for the money invested. The New Zealand Government has proved its practicability.

Our own farm colonies have proved that similar efforts are applicable to this country. The Indian Government has also shown that such plans can successfully be put into operation. With an expenditure of $125,000,000 on their Irrigation and per cent on some works which are of a purely precautionary character, to guard against famine and failure of crops. During nine years, no less than 800,000 people have been settled upon these lands by the Indian Government.

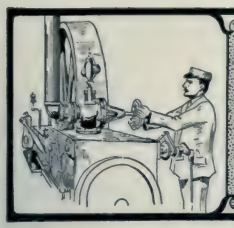
IMPOSSIBILITIES REALIZED BY DILIGENCE AND THRIFT.

Herd of cattle on the farm of a colonist at Fort Romie, California. Five years ago this colonist was earning $6 a week in San Francisco. He has been about four years on the colony. Last year his income was $1,250; the year before, $1,150—all from twenty acres of irrigated land and the herd of cows here shown.

Colonization works, not only have they been able to pay 3½ per cent interest on the capital invested; but the Government, in addition to this, has made a net profit, according to recent figures, of no less than 3.04 per cent, or a clear annual profit of something like three and one-half million dollars. The rate of profit has varied in India, from 23 per cent on the East Jumna Canal, to as low as 2.12

It is now proposed gradually to bring 100,000,000 acres of land under irrigation in the United States. Here then is a magnificent opportunity for settling these lands on the lines indicated, with multitudes of happy and prosperous home owners.

I trust that THE TECHNICAL WORLD may play a leading part in helping forward this greatly to be desired enterprise.



ENGINEERING PROGRESS

The Automobile on Parade

THE USE OF THE AUTOMOBILE in parades and fêtes in the United States is becoming quite common. At a recent procession in honor of the Society of the Elks in Minneapolis, Minn., a touring carriage won a prize for the best original

A Uniquely Decorated Automobile.

decoration. It consisted of the head of an elk joined to the vehicle in such a way that it would appear as if the little girl standing on the seat were guiding the animal by the white ribbons attached to its horns. The design was arranged by Mr. A. C. Bennett, of Mankato, Minn., the owner of the carriage.

The other picture represents May Day festivities with automobiles in California. The vehicles are shown in what was called a "ribbon quadrille." One was placed in the center, and the other motors circled around it in such a way as gradually to wind the ribbon into a colored rope, the vehicles pausing when massed around the center one. The evolutions required very skillful steering and control of the machines. Several of them were guided entirely by lady chauffeurs.

World's Largest Tractor

A 125-HORSE-POWER TRACTION ENGINE, the largest in the world, has made its appearance in California. It was built by the Best Manufacturing Company, of San Leandro. The engine, 17 feet high and 15 feet wide from outer edge to outer edge of its enormous wheels, can climb a 25 per cent grade carrying 20 tons. The engine tanks hold 600 gallons of water, sufficient to last for a distance of six

The Ribbon Quadrille.

miles, and an additional 600 gallons can be carried in the front part of the first wagon. As many tanks as desired can thus be added, but, as their weight detracts from the hauling power, it is considered advisable to replenish the water

supply every six or twelve miles when possible.

Tests have demonstrated that this pon-

GREATEST TRACTION ENGINE.

derous machine costs but $18 a day for operation. Oil, coal, and wood can be used for fuel with equally good results, without altering the fire box. An oil-burning attachment is furnished when oil fuel is desired. To operate the train requires an engineer and fireman. When freighting in the mountains, however, a third man may be required to attend brakes when descending steep grades, and also to help load and unload the train. Engines of this type, but of smaller size, are used throughout California and the Pacific coast, in hauling logs, lumber, and other kinds of material, some of the large milling companies in this part of the country including in their equipment as many as five or six of them.

Big Coast Freighter

BORN IN SAN FRANCISCO and christened the *Arizonian,* the largest merchant vessel on the Pacific coast has just issued from its cradle in the Union Iron Works dock, as the latest commercial product of the wedding of the Pacific coast to the islands of the Eastern seas. The *Arizonian* belongs to the American-Hawaiian Steamship Company, and is the youngest of that family of great freight steamers to which belong the *Texas* and the *Alaskan.* She will soon go into the Hawaiian trade and will make both Pacific and Atlantic ports.

The *Arizonian* has a gross tonnage of 8,671, and 5,621 tons net. Her carrying capacity is 11,000 tons. She is driven by quadruple-expansion engines with cylinders 21 2-5, 28, 38, and 60 inches' diameter respectively and a stroke of 30 inches. At 240 pounds' pressure the engines will develop 3,000 horse-power.

PACIFIC COAST FREIGHTER *ARIZONIAN.*

Automatic Trench Digger

A MACHINE designed to take the place of manual labor in digging trenches, has recently been used in excavating a sewer at Moorestown, New Jersey, with very satisfactory results. The material required to be removed consists largely of a hard clay, which would necessitate more than the ordinary amount of labor with pick and shovel. The machine referred to excavated a trench four feet in depth and

from two to three feet in width, at an average rate of 60 feet an hour; the contractors estimated that it performed the work of from 50 to 75 laborers.

As indicated in the accompanying illustration, the excavator is of what is

AUTOMATIC TRENCH DIGGER IN OPERATION.

known as the "chain" pattern, passing over sprockets fastened at each end of a beam shaft which can be raised or lowered at the will of the operator, and which acts as a guide in securing the required depth. As the material is cut away from the breast of the bank, it is raised by means of a steam gear which continually holds the excavating and raising mechanism in place, aided by the weight of the machine itself.

The digger is also moved automatically. A post is driven about 100 feet in front, to which is fastened a cable connecting with a drum or cylinder on the front of the digging machine. At each revolution of the excavating shaft, the cable is taken up by winding the drum. The power is supplied by a traction engine, which is also utilized in moving the machine from place to place when it is not transported by rail.

The engine is connected with the digging machine by a chain belt passing around the shaft of the excavating outfit.

World's Largest Searchlight

MAN'S NEAREST APPROACH to producing the power of sunlight is a searchlight that has just been built by the Schuckert company of Nuremberg. This miniature mechanical sun will throw its rays eighty miles away, and thus would be visible clear across Lake Michigan. Such a distance of reflection, however, could not be obtained unless the light were elevated to a proper height, which at present is impossible. The builders say that it might shine farther than eighty miles, no thorough test of its actual powers having yet been made.

The light is of 316,000,000 candlepower and is the largest searchlight ever built. It is fitted with an iris shutter having a diameter of 6 feet 6 inches, which was adopted in order to make the

WORLD'S LARGEST SEARCHLIGHT.
Throws a beam of light over eighty miles

projector light-tight at any moment desired, and which is operated in much the same way as an ordinary camera shutter.

The leaves of the shutter slide within a fixed diaphragm located in the axis of the beam of light. The whole device is electrically controlled by two levers. One of the levers controls the motor mounted in the base of the searchlight, which operates the projector in a vertical direction through a train of gears; the other starts or stops the electric motor which controls the horizontal movement of the beam of light.

STEAMBOAT TRAVELING OVERLAND.

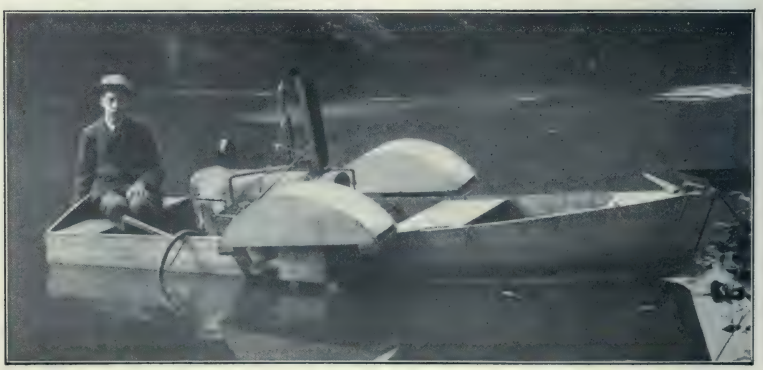
Steamer Travels Overland

A STEAMBOAT traveling along a dirt road was a novel sight recently witnessed in Michigan. The feat was made possible only by the power of the traction engine, two of them being employed to haul the boat from Alpena to Long Lake, a distance of eight miles. The vessel was the twin-screw steamer *Josie,* of 50 tons' burden. All along the route people thronged to see the novel spectacle. The traction engines were of 25 and 16 horsepower respectively.

Boy Builds a Steamboat

ALL THE BOYS in Madison, N. J., envy William Webb Davis, Jr. He has built for himself a little steamboat, in which—often accompanied by his sweetheart—he rides about on the picturesque Passaic river, visiting interesting points for miles around. The boat is but the latest of young Davis's mechanical achievements. He also has an automobile which he built all by himself, and the boy is only 16 years old. Here is his description of the boat:

"First I made the boat 12 feet long and 3 feet 6 inches beam. The sides are cypress and the bottom is white pine. The bow and stern have water-tight compartments. The paddle-wheels do not come below the bottom of the boat because the Passaic river is very



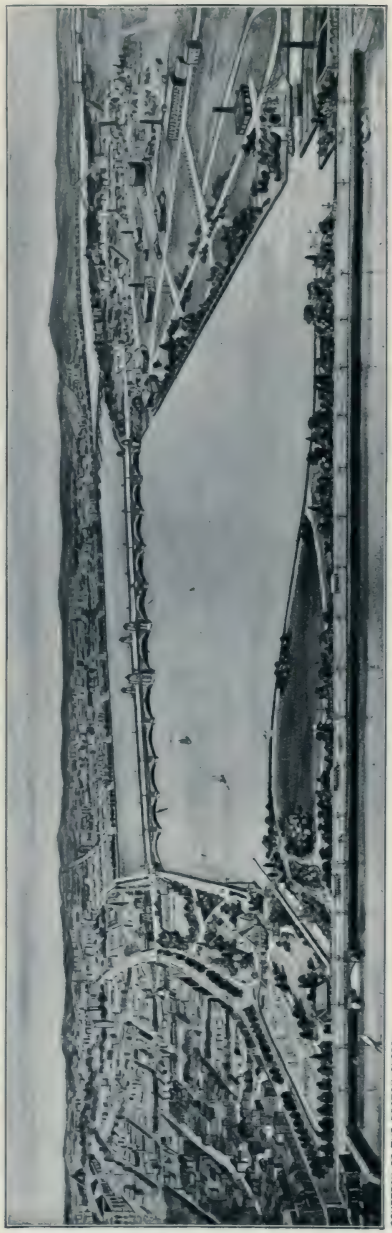
W. W. DAVIS, JR., IN STEAMBOAT HE BUILT HIMSELF.

shallow in places. The paddle-wheels and paddle boxes are removable, thus making it easy for transportation. The boiler is made of 8-inch wrought-iron pipe. I had a piece two feet long, with a cap on each end, and then drilled holes for the piping. The boiler jacket is made from sheet iron covered with asbestos, which also makes the firebox. The motive power is an upright engine of about one horsepower connected to the paddle shaft by a bicycle chain. I made a small check pump with two half-inch checks and a piece of half-inch brass pipe for the cylinder. The pump not only forces water into the boiler against steam pressure, but also acts as a bilge pump. I am now using wood for fuel, although I made gasoline burners and used them for a while. The boiler is equipped with steam gauge, safety valve, and whistle. The exhaust steam from the engine goes up the stack to make a forced draft. At the end of the boiler is a water glass showing the amount of water in the boiler. The boat may be steered by a person in the bow by means of a lever connected to the rudder with ropes."

Basin Will Beautify Boston

SPANNED by two of America's prettiest and finest bridges, surrounded by splendid parks and driveways, and located in one of the most picturesque parts of picturesque Boston, the proposed Charles River Basin is destined to be one of the handsomest municipal ornamentations in the world. The work is in the hands of a special commission, which will soon advertise for bids with a view of pushing the enterprise to a speedy completion. The basin will be formed by damming the Charles river and dredging the stream. The Congressional resolution authorizing the work provides that the Commonwealth of Massachusetts shall maintain the necessary depth and width of channel for the commerce of the river as fixed by the Secretary of War. The Basin Commission must operate the lock at its own expense, as a free navigable waterway of the United States, subject to such regulations as the Secretary of War may promulgate.

The dam, in deepening the stream, will add greatly to the importance of the waterway. The commission is required to maintain in the basin, from the head of the lock to the channel in the river, a channel 100 feet wide and 18

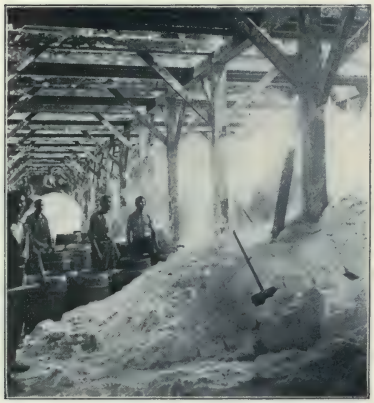


GENERAL VIEW OF PROPOSED CHARLES RIVER BASIN, BOSTON, MASS.

COURTESY OF THE BOSTON GLOBE.

feet deep at mean low water. Traffic in the basin, however, is to be given up to pleasure craft for the present, as the entire work is for the purpose of affording a place of public amusement and to beautify the city.

The accompanying sketch of the basin is from a large water-color by Walter P. R. Pember, made for the purpose of being placed upon the walls of the Massachusetts Building at the St. Louis Exposition. In the foreground appears the proposed dam, which will take the place of the present Craigie bridge, and hold back the waters so as to form the basin beyond. The dam is to be traversed by a wide and beautiful driveway, and will be 100 feet wide on top. The lock, which will be 350 feet long and 40 feet wide, will be a novelty in Boston. On the left or south side of the picture appears the present Charles Bank, which extends from Leverett street to Cambridge and marks the beginning of the great Charles River improvement work.



Handling Salt by Hand.

On the right or north side of the picture, is shown that part of the Cambridge River Park, known as the "Front." It is pierced at its easterly end by the Lechmere, and, further along, by the Broad canal. Extending across the center of the basin is shown the magnificent new West Boston bridge, joining Boston and Cambridge. Work on this bridge is now rapidly progressing, and the structure is to be opened for traffic next summer. This will be one of the finest and most artistic bridges of the modern world. In a bend of the river beyond, is the present Harvard bridge, resplendent at night with its graceful spans and its scores of lights reflected in the water.

The parkway will be continued from the Charles Bank southward and westward past the Union Boat Clubhouse, and along that part of the river on which the Beacon street mansions abut. All of this section is to be filled in to a width of about 100 feet, and connected with the Back Bay fens near Massachusetts avenue. This splendid boulevard will be planted with shade trees and shrubs, and will probably be connected with the West Boston bridge by a graceful sweep.

Boat landings will be located at frequent intervals on both sides of the basin for the benefit of those who wish to indulge in the pleasures of canoeing, riding in row boats, electric launches, and other pleasure craft.

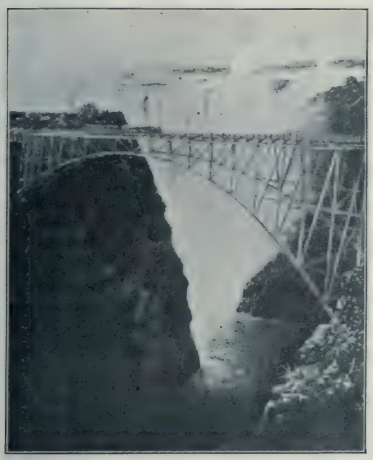
Handling Salt by Compressed Air.

Compressed Air vs. Hand Power

IN THE CITY of Muskegon, Michigan, salt is used in large quantities, and consequently the warehouses of the firms dealing in it are capacious enough to store away a very considerable supply. As is well known, salt, on account of its affinity for water, is a substance that has a tendency

to harden and cake when piled away any length of time, and some of the cellars where it is stored contain beds of it twenty feet high and so hard that but little impression can be made upon them even with the pick or axe.

For this reason a somewhat curious device has been brought into use to loosen the material so that it can readily be secured. This is a large boring tool or auger which is operated by compressed air. As the photographs show,



Proposed Bridge across Zambesi River at Victoria Falls, on route of Cape-to-Cairo Railway.

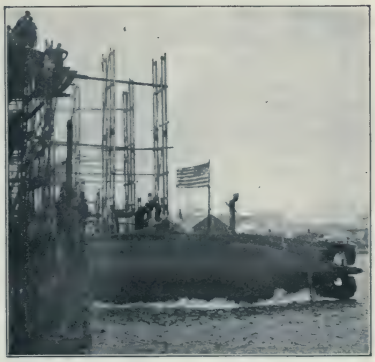
the auger is mounted on a wheeled truck which is guided by handles projecting from the rear of the framework. The rear end of the auger revolves in a socket fitted into the framework, while the air is admitted to the socket from the hose which supplies it. When operated, the boring tool is pushed against the mass of salt, and the auger is set in motion; and in a minute or two—so rapidly does the tool work—a hole about five inches in diameter is made in the formation the entire length of the auger. Then another hole is drilled parallel with the first, and another, until the pile has been undermined, so to speak, when its contents can easily be broken out. The advantage of this method is seen when it is stated that two men can get out as much salt by the power method as two dozen men by using picks and shovels.

Great African Bridge

VICTORIA FALLS in Rhodesia, twice the width and more than double the height of the far-famed Niagara, are to be spanned by an enormous bridge to form a link in the Cape-to-Cairo Railway. The bridge will be 600 feet high, with a span of 500 feet, which would be high enough to permit nearly two of America's tallest skyscrapers to rest under it. The falls are on the Zambesi river, and were discovered by Livingstone in 1855, during his African explorations. Plans for the great bridge have already been prepared in London, and work is to begin without delay.

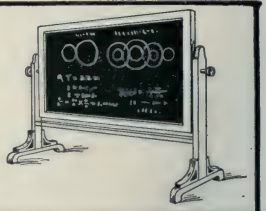
Powerful New Submarines

TWO FORMIDABLE SUBMARINE BOATS have recently been launched at the yards of the Union Iron Works of San Francisco, California. They are the *Pike* and the *Grampus,* each of 120 tons' displacement and built for a speed of eight knots an hour. Their cost is $170,000 each.



Launching Submarine "Pike."

CHALK TALKS



by CARL S. DOW.

Number Eight—Capacity of Pumps

IN FINDING the capacity of a direct-acting pump, the water-end only need be considered. The steam-end is taken into account when the calculation involves the pressure against which the pump is to force the water. The size of the steam-end of a pump determines the *pressure* of the water issuing from the water-end, but has nothing to do with the *amount* of water delivered.

In the direct-acting pump, the water cylinder fills with water when the piston moves. Thus, when the piston is moving toward the right, the water follows it, filling more or less completely the right-hand end. On the return stroke, the piston forces this water out of the cylinder. Thus we see that the volume of water pumped per stroke is equal to the volume of the cylinder; or, to be more exact, the volume swept by the piston. This is also called the "piston displacement."

Calculation

The finding of the cylindrical volume of the piston displacement is no different from the finding of the volume of any right cylinder. Therefore we use the rules of mensuration. The volume of any cylinder is equal to the area of the right section (or piston) *multiplied by* its length (or stroke). In the first figure on the blackboard, let D represent the diameter of the pump of the cylinder, and L the distance the piston moves at each stroke. Let us suppose, for example, that the pump is an 8x10; that is, the water cylinder is 8 inches in diameter, and the stroke is 10 inches in length. From the rules in mensuration, we know that the area of the circle representing the piston is found by multiplying .7854 by the square of the diameter. This would give us for the area:

$$.7854 \times 64 = 50.265$$

To find the volume, we simply multiply this area by the length of stroke, 10. This gives us the volume of the cylinder in cubic inches, since all the dimensions were in inches.

Experiment shows that there are 231 cubic inches in a gallon. Then, to find the capacity of this pump in gallons, we divide the volume in cubic inches by 231, which gives us 2.176 gallons per stroke. To find the capacity per minute, we simply multiply this by the number of strokes per minute.

In the above example, we had two constants—that is, two numbers that would remain the same whatever the dimensions of the pump might be. In the first place we multiplied by .7854. Later we divided by 231. As this calculation must be performed each time, we can do it once for all and obtain a new constant. Thus,

$$.7854 \div 231 = .0034$$

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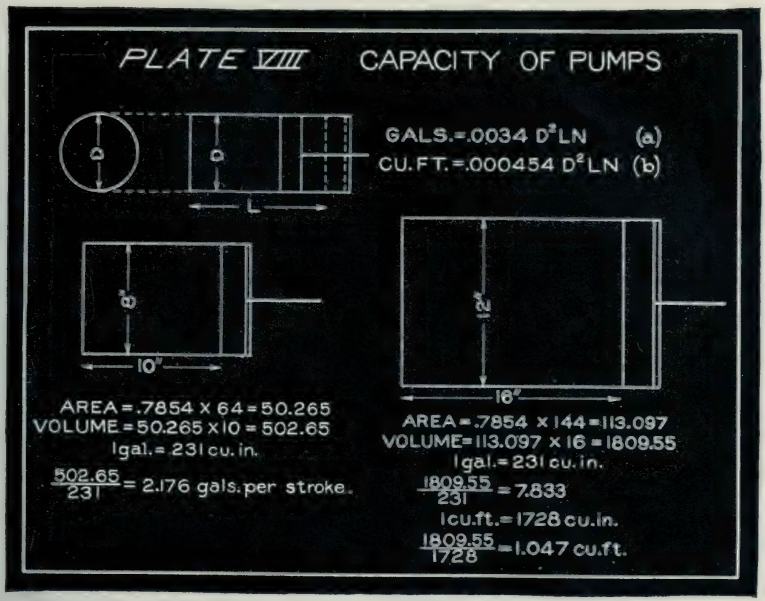


Now, by using the letters D, L, and N to represent the diameter, length of stroke, and number of strokes, respectively, we get the simple formula (*a*).

Let us take another example and find the capacity of the pump both in cubic feet and in gallons. Suppose the pump is a 12x16. The volume in cubic inches is found as shown in the calculation on the blackboard to be 1,809.55. As before, we divide by 231, and get as a result 7.833 gallons. Now, we know that one cubic foot equals 1,728 cubic inches. To find the capacity in cubic feet, we divide the volume in cubic inches by 1,728, giving us 1.047, which is the capacity of the pump in cubic feet per stroke. As in the first example, we use two constants, namely .7854 and 1,728. We can combine these constants into one by the same process. This gives us the fundamental formula shown at (*b*).

Losses

The above calculations give the theoretical capacity of a pump in cubic feet per stroke and in gallons per stroke. In practice, the amount of water delivered will be somewhat less than this, because the stroke of a direct-acting pump varies somewhat, and there is some loss from leakage. Losses vary with the type of pump, the speed, the pressure, and the method of taking water. The losses are much smaller for large pumps than for small pumps, and they are smaller for low speed than for high speed. The loss for leakage, etc., in a large pump varies from 3 to 10 per cent. In small pumps it may go as high as 40 per cent. As a rough general average, we may take 25 per cent as the loss; and to find the actual capacity, we multiply the results of the above calculations by .75.

Other formulas similar to those given in (*a*) and (*b*) can readily be made to suit the conditions—that is, when the diameter is given in feet and the stroke in inches, or the stroke in feet and the diameter in inches. But those given should be sufficient for most cases, as the sizes of pumps are practically always given in inches.

Life Stories of Successful Men

William Ellis Corey

By HENRY M. HYDE

Editorial Writer on the *Chicago Tribune*

REMARKABLE, even among that remarkable company of young millionaires known as "the thirty-five young partners of Andrew Carnegie," is William Ellis Corey, the present president of the United States Steel Corporation, better known as the "Steel Trust."

Mr. Corey is but thirty-seven years old; yet he went to work no less than twenty-one years ago for Andrew Carnegie, as a boy of sixteen, with no more than a grammar school education. Step by step he has climbed up in the service of the great steel master, until, when Charles M. Schwab was made the first president of the Steel Trust, Corey succeeded him at the head of the Carnegie Company, its largest and most important constituent concern. And later, when Schwab's retirement was forced, Corey was Carnegie's choice as his successor in the position of president of the largest and most powerful corporation ever formed.

The annual salary drawn by "Bill" Corey, as his old mates in the mill still call him, has been variously stated in the newspapers from a round million to a hundred thousand a year. Certainly it is one of the largest salaries ever paid, and it is even more certain that there are few positions in the world the occupants of which wield power as great or as far-reaching.

To review the life story of William E. Corey is to discover nothing especially new or startling. It is simply to add new and stronger emphasis to the importance of the possession of those simple and fundamental qualities which are found at the bottom of most successful careers. And it is precisely because these qualities are so persistent and so easily understood, that the ambitious young man, no matter what his station in life, should find in them the greatest possible inspiration and encouragement. If success were a matter of genius or due to some other equally mysterious cause, a young man who did not feel the fires of genius burning within him might well despair. When he finds that in practically every case success is due to hard work and a never-satisfied desire for exact knowledge, he may well conclude that the coveted prize lies within his grasp.

It is true that unequaled opportunities were offered to Corey and the other young men who entered the employ of the Carnegie Company, yet it is also true that out of the thousands who entered that employ only thirty-five or forty won their way upward to great success.

"Diligence," as Poor Richard says, was, in the case of Corey and his successful colleagues, "the mother and father of good luck."

It is told of Corey that he first entered the Carnegie service as a laborer at one dollar a day, and that his first work was hauling ore in a wheelbarrow. He wheeled so much more ore than any other member of the gang that he was presently made foreman over the others. In that capacity he got so much more work out of his men than the other foremen that he was promoted to a still higher position. It is a good story, and it is a pity to spoil it, but Mr. Corey himself gives it the lie.

"I was a mere boy when I went to work," he says, "and I could not have hauled half a load of ore in a barrow. Nor were my wages one dollar a day. They were a good deal less than that amount."

As a matter of fact, when Corey was sixteen years old, he quit school and got

a small job as a helper in the chemical laboratory connected with the Edgar Thomson Steel Works. And there, at the start, the qualities which are responsible for his success showed themselves. In the working hours, he did the rough work in and about the laboratory. In the evening, he read and studied books on chemistry and metallurgy which he borrowed from his superiors in the laboratory. The industry of the boy and his great desire for knowledge, quickly made an impression on the men immediately over him. They took an interest in his welfare, lent him more books, and helped him to direct his study in the best channels. *It is almost always true that a diligent youth finds many friends and helpers.*

A few years of hard study, while he was still working in the chemical laboratory, made Corey an authority on the chemistry of steel making; and when, in 1888, Charles M. Schwab was promoted from the position of superintendent of the plate mills and open hearth department, the young Corey, then just in his twenty-first year, was appointed to succeed him.

It was a hard task for a boy, just come of age, to undertake to superintend the work of hundreds of grown men and expert workmen; but Corey soon demonstrated that he knew all the details of the steel-making industry even a little better than the men who actually did the manual labor, and that demonstration quickly won the respect of the men under him. There is nothing which will so greatly help an executive in maintaining discipline among his subordinates as the realization on their part that he is their master in knowledge and skill.

Thanks to his home study in the science of steel making, Corey was able, soon after he took charge, to introduce some important economies in the mills. He also made some valuable innovations in the manufacture of armor plates, which greatly strengthened the hands of his company in its efforts to secure, at a large profit, the contract for supplying the National Government with the armor for sheathing its battleships and cruisers. As the practical head of the plate mills, Corey was called upon to fill this difficult contract; and, in successfully performing the work, all his expert chemical and technical knowledge, acquired so largely by out-of-working-hours study, was called into play. The papers were full at the time of the great controversy between the officials of the Navy Department and the heads of the Carnegie Company over the armor-plate contract; but one heard nothing of this young and self-educated engineer, whose skill and knowledge were among the determining factors in the case.

But he did the work and did it satisfactorily, and the keen eyes of Andrew Carnegie did not overlook his services. From that time on, his promotion was rapid and constant. He was made General Superintendent of the Carnegie Company, and finally, in 1901, when the Steel Trust was organized, he became president of the Carnegie Company.

In personal appearance Mr. Corey is a rather short, heavily-built man, with a fresh complexion, a small moustache, and an unwrinkled face which makes him look even younger than he really is.

In manner he is brisk and energetic. He wears loose and comfortably fitting clothes, and is democratic in his manners. He has never lost his great interest in the practical processes of making the various steel and iron products; and, as the present head of the steel corporation, it is understood that he devotes most of his time to their direction, leaving the handling of the financial problems connected with the administration to men especially trained in that direction. He is essentially an example of a successful technical man in the great steel industry.

The Automobile's Successor

SOCIETY'S NEWEST VEHICLE is the auto-chair. It first made its appearance at the St. Louis Exposition, and, because of its convenience, neatness, and simplicity, at once sprang into favor. It is destined soon to be seen in large numbers on the fashionable streets and boule-

Auto-Chair in Use.

vards of New York and Chicago. By many this new type of vehicle is already proclaimed the automobile's successor. It can be manufactured much cheaper than the automobile, and for shopping and light usage it has no equal. The chair takes the form of a low phaeton without a cover. There are four wheels — two large rear wheels, and two small ones under the foot rest. All are pneumatic-tired. The seats are upholstered in cane like those in street cars. Behind the seat is a box which contains the batteries that furnish the motive power.

Belt Conveyors

ALTHOUGH belt conveyors have for years been used in the handling of grain in most large elevators, it is only recently that they have been found capable of a much wider application. Such materials as coal, coke, ashes, crushed stone, ores, boxes and barrels—in fact,

Belt Conveyor Carrying Coal.

all substances except those which will directly destroy the belt by chemical action or heat—can be handled in this

way with dispatch and economy. So radical was this innovation on former methods that many at first doubted its practicability, but its success was soon demonstrated. The accompanying cut illustrates a belt conveyor delivering lump coal.

A special convenience may be served by the attachment of a "tripper" whereby the material can be delivered at any desired intermediate point.

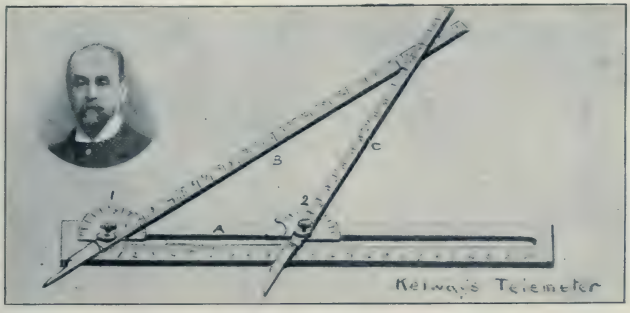


FIG. 1. MR. KELWAY AND HIS TELEMETER.

Firing at Unseen Objects

WIRELESS TELEGRAPHY, and a new invention known as Kelway's telemeter, have enabled the Japanese battleships successfully to hit unseen targets miles away. The telemeter and an accompanying stop-watch are the invention of C. E. Kelway, an Englishman. The system may be understood by reference to the illustrations.

Cruisers 1 and 2 (Fig. 2) are for observation only. They lie within sight of the town, but out of range of the shore batteries. The firing ship 3 lies where, owing to the contour of the ground, it cannot be hit by the forts, but within range of the town. It cannot, however, see its target. When about to fire, ship 3 warns 1 and 2 by wireless telegraphic bell. They watch for the bursting of the shell and each takes the time between the flash and the report by means of Kelway's stop-watch, which gives the distance of each observation ship from the point of explosion.

With their known distance apart as base-line A, they set off the distance B

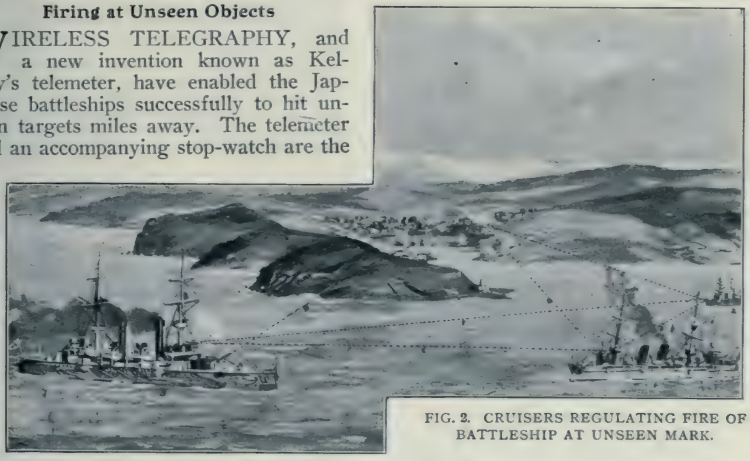


FIG. 2. CRUISERS REGULATING FIRE OF BATTLESHIP AT UNSEEN MARK.

and C on the telemeter (Fig. 1), and obtain the triangle;* which, when applied

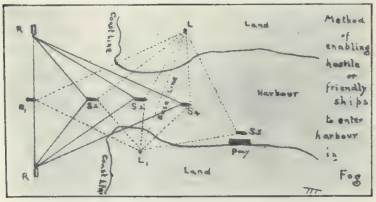
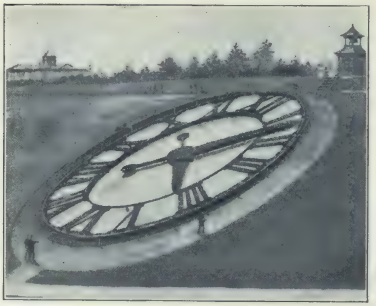


Fig. 3. Method of Guiding Ship to Quay.

to the chart of the town, shows the point where the shell fired along trajectory D has burst. Errors in gunnery are thus corrected by wireless telegraphic signals to the firing ship.

Similarly by observing times of report of gun in ship 3, ships 1 and 2 can learn their position relative to that vessel.

In Fig. 3, L and L_1 are signalling stations on shore. S_1 is a friendly ship approaching a quay. The base-line L L_1 is known. L and L_1, at intervals of 30 seconds, sound a signal, at the same time notifying the moment of sounding to S_1 by Hertzian waves. The distances S_1L



Floral Clock at St. Louis Exposition.

and S_1L_1 are thus ascertained, and the ship learns her position. Similar observations taken at S_2, S_3, S_4, S_5 give the dotted triangles, and bring the vessel safely in. In war time the base-line is given by two moored cruisers R R, which, by the same method of signals, give the ship the series of triangles marked by the black lines, thus enabling her to enter the harbor.

*The numbers and letters on the telemeter correspond with the ships and distances observed.

Colossal Floral Clock

AN IMMENSE FLORAL CLOCK, which, by a masterly interior mechanism, is made to keep correct time, is one of the most interesting attractions at the St. Louis World's Fair. The dial of the clock is 100 feet in diameter. The minute hand is 50 feet long and 6 feet wide.

Double Lightning Flash

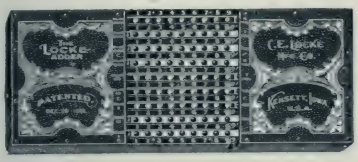
THE PHOTOGRAPH reproduced in the accompanying cut is not of a single lightning flash but of a double flash. It was taken by Mr. H. McKillip, of Bloomsburg, Pa. Mr. McKillip was endeavoring to secure a good lightning

Double Lightning Flash.
An unusual coincidence caught by the camera.

picture during a thunderstorm, and, after waiting for nearly an hour and obtaining only specimens of sheet lightning, noted a flash which began near the center of the line of vision and shot downward. As he was about to close the shutter of the lens, he was surprised to note another flash which extended from right to left nearly meeting the vertical bolt. He left the shutter open with the result that appears in the picture. It is probably the only case on record where two flashes of lightning have ever been photographed in such quick succession, or have assumed such a peculiar shape.

A Mechanical Calculator

CALCULATING BY MACHINERY some time ago became a substantial reality, but has now been brought within the reach of everybody through the invention of a remarkable little contrivance by Clarence E. Locke of Kensett, Iowa.



The Locke Adder.

Mr. Locke has named his invention the "Locke Adder;" but it can also multiply, subtract, divide, and perform all other kinds of arithmetical work in about one-fourth the time taken by the most skilled accountant. There is no need of an expert accountant to do the work of this machine. So far as the calculations are concerned, he might be discharged at once, and the office boy could be taught to do his work in a day. Thus machinery is not only doing away with manual labor, but it is beginning to take the place of brains.

With the Locke adder, calculating of any kind becomes purely a mechanical process. Thinking is not necessary, more than is required to place the fingers on the numbers indicated in the problem one has to solve. All the living accountant has to do is place his fingers on the keys. The machine—the inanimate accountant—will do the rest, quicker by far than the human accountant, and it will never make the slightest mistake. It is impossible for the machine to err.

The machine, invented by man, that can perform all these things, will not weigh a third as much as the best human accountant's brain. It is a very small contrivance—weighing just 7 ounces—which can be placed in a corner of the desk, or used as a paper weight, or carried in the pocket. Its ability never becomes impaired from intemperance or overwork, it is honest, and ever in readiness to solve the most intricate problems.

The adder consists of a frame or casing containing a series of parallel bars, the central portions of which are exposed while the ends are covered by plates. There are two kinds of bars—the stationary guide bars and the sliding bars. The guide bars, on their upper surface, have the numerals 1 to 9 equally spaced in regular sequence from left to right. Between the guide bars, and adapted to move from right to left or left to right, are the sliding bars. Each of these bars is about twice as long as the exposed portion of the guide bars, and has on its upper surface a series of projections or knobs, spaced at the same intervals as the numerals on the guide bars. When these bars are moved to the right or left, the figures indicating results appear in the U-shaped openings at the right of the operating section. The result figures are read down, or toward the operator, and are in plain sight, yet so placed that there is no danger of confusing them with the numerals on the guide bars.

Different sliding bars represent different orders in the decimal notation—the lowest or nearest slide being units, the next tens, the next hundreds, and so on—the top bar being hundreds of millions. Guide words and figures on the plates make everything plain to the beginner.

Maid of the Mist

THE REMARKABLE IMAGE shown in the accompanying photograph was developed on a film which was exposed by a tourist at Niagara Falls. The traveler decided to get a view of the Canadian Fall with a pocket camera, little

Maid of the Mist.
A caprice of vapor effect caught by the camera.

knowing that the lens had caught and reproduced the figure of a woman rising from the mist. On examination of the accompanying view, however, the figure can be seen clearly defined at the left of the picture. It was probably merely some weird creation of the mist cloud that hangs over the cataract, produced by air currents.

Ideal Life Preserver

A LIFE-SAVING SUIT that will enable the wearer to remain in the water indefinitely without experiencing discomfort, has been invented by M.

Joseph Probst in His Life Suit.

Joseph Probst of Geneva, Switzerland. After him it is named the Probst Life Suit. A person can don the suit, it is claimed, as quickly as he can place an ordinary life belt around him; and when it is on, he is absolutely safe against the roughest sea that ever raged. Food and water are carried in apartments in the suit. The inventor, to test the powers of his device, recently remained in the water for a whole month, and reported that he enjoyed his experience as much as a cruise in a sailing vessel. The suit is of India rubber and opens in the center. On the outside are air-tight compartments large enough to carry all necessary supplies, including an instrument to scare away pillaging fish. The suit rests lightly on the waves almost one half of it being above water. The wearer may lie down or stand up in it.

Two-Legged Cats.
Their tails partially serve the purpose of hind legs.

Biped Cats

THESE KITTENS are very much like other kittens with the exception that they have no hind legs. Out of a litter of seven, they were born with but four legs between them. However, this makes but very little difference, as they are able to support themselves on their tails, and can get about without difficulty and very quickly. They are now several months old, and as active and healthy as the average feline. Mrs. Taylor, their owner, is a colored woman residing in Baltimore. She is very proud of her pets, and has refused an offer of $10 each for them.

A Hurricane's Path

THIS PICTURE is a forcible reminder of what the wind can do in the space of five minutes. It is a view of the track of a hurricane which passed over a part of the city of Baltimore. Directly in

the path of the hurricane stood a massive brick machine shop used by a railroad company for making repairs to its cars. It was literally filled with heavy boring tools, power lathes, power hammers, and other equipment. The building was constructed of a framework of hardwood beams 18 inches square, and the outer brick walls were nearly three feet thick. Within actually five minutes after the tornado struck the building, this scene of ruin was presented, the portion in the path of the storm being literally cut out, leaving the ends of the building intact,

FIVE MINUTES' WORK OF A HURRICANE.

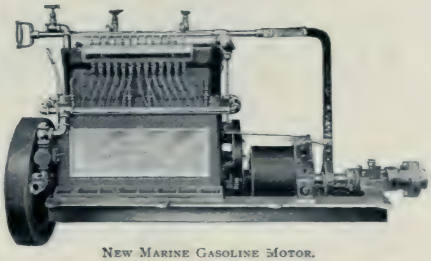
with their equipment uninjured. The picture shows how the brick and stone were torn apart, and how the framework was crushed to pieces, while every machine was thrown from its foundations.

New Type Marine Motors

MARINE MOTORING has sprung into unexpected prominence recently as the result of improved machinery that makes the diversion more enjoyable and safer than its early advocates ever anticipated. What the automobile is to the land, the motor launch now is to the water. But the danger is no greater and the sport is declared to be more healthful and exhilarating than automobiling, while the cost of outfit and supplies is less.

New style motors, doing away with the many inconveniences of the old-type machines, are responsible for the phenomenal popularity that the gasoline launch has attained. One of the most remarkable of these new motors comes from Buffalo, N. Y., where it is manufactured by the Buffalo Gasoline Motor Company. All the four cylinders of this motor are fed with a carburettor through one inlet casting. With all the motors, are furnished a float-feed carburettor, which is attached directly to the motor and contains a throttle for gauging the amount of gasified vapor admitted to the cylinders. Attached to this is a lever of neat design, located near the sparker lever, so that the sparking and throttling are conveniently and easily operated.

The new motors contain solid, one-piece, steel-forged crank shafts and mechanically operated inlet valves. This insures a regular supply, which in turn gives a steady, measured impulse and regular speed. This is a wonderful improvement over the troublesome cranking motor which would not start because the inlet valves were stuck to the seats. All motors of this new type are equipped



NEW MARINE GASOLINE MOTOR.

with metal-enclosed bases, with sufficiently enlarged detachable panels, so that access to all parts is easy. Solid steel-forged valves are used, and are accurately ground to a good seat. Five heavy bearings in the base of the motor assure firm journals for the crank shaft. Double-lock nuts and split keys hold these bearing caps in proper place, and consequently there is no trouble from lost nuts and loose bearings. The motors are completely water-jacketed, including head and valves. There is no packing except on the water-jacket plate; there is never any trouble with this because there is no pressure to blow it out. The

sparker plugs on top of the motors have double-seated ground joints, absolutely compression tight. The steel-forged cams, operating inlet and outlet valves, are all on one shaft, and are pinned on in order to insure opening of the valve at absolutely the right time. The valve plugs are just above the valves in the center. Should any valve leak, it can be taken out immediately, reground, replaced, and made ready to run in a very short time.

The illustration shows a two-cylinder 7½ horse-power balanced motor of this type. It has a bore of 4½ inches; stroke, 5 inches; weight, 395 pounds without reverse gear, or 545 pounds with bed and reverse gear; diameter of fly wheel, 16 inches; diameter of shaft, 1⅜ inches. The speed can be changed instantly at the will of the operator from, say, 600 normal to 1,000 maximum. The length of the motor over all is but 15 inches, exclusive of 6 inches of shaft on both ends. The foundation is but 13⅛ inches long, and the width is 14½ inches.

Universal Square and Protractor

AMONG MANY DEVICES brought out in recent years for the specific requirements of mechanical draftsmen, a form of square has just appeared that is peculiarly adapted to the rapid and easy performance of that class of work. Machine designers and structural draftsmen will generally recognize that, except for bolt heads and short work, ruling edges of 60 degrees' and 45 degrees' slope are seldom required, but for this purpose they are in almost constant demand, while, on the other hand, the presence of the two ordinary 60- and 45-degree triangles on the drawing board is a continual nuisance.

The ingenious instrument referred to—the invention of Mr. Duane J. Kelsey, New Haven, Conn.—does away with the two triangles, and supplies in addition several valuable requirements. It is primarily a square of large range and light weight, in thorough control from a knob located near its center of gravity. Its arms are secured at right angles to each other under an aluminum plate, and are thus easily adjusted, repaired, or replaced. As usually made, it has transparent celluloid edges, but, if desired, the inner edges are provided with accurate scales turned down to meet the paper with a very slight thickness of ruling edges, thus rendering practical a large proportion of the petty measurements of a drawing without the use of a separate scale.

The drawing of square, hexagonal, and wood screw heads is provided for in the central portion of the instrument which is a transparent celluloid plate having a large arc, bevelled on the edge and graduated to degrees.

The instrument measures all angles from horizontal or perpendicular lines on the drawing, and also provides for laying them off. For the drawing of odd angle work, including structural designs, special projections, cams, etc., it is peculiarly adapted by means of a base attachment to which the square is clamped by a few turns of the knob. This base has a vernier limb reading to 10°, and rides against the T-square on all parts of the board, providing for lines at any angle *and their perpendiculars*, at one setting. Angle work is thus made more rapid and easy than square work.

Another convenience of no small amount is the avoidance of shadows when working by artificial light, as one side or the other of each arm is always in more or less direct light. The polished metal plates and trimmings give the instrument a substantial and pleasing appearance, and its manipulation is as easy as that of triangles of much smaller range.

RUSSELL SAGE.
The Great Money-Lender of New York.

Practical Talks by Practical Men

Thrift and Happiness

The Gospel of Saving Discussed by one of the Richest of American Millionaires

FOR over twenty-five years Russell Sage has been known to the average American as one of the shrewdest of the many prominent business men in New York City, and for an equal term of years he has been the target for all manner of cheap newspaper witticisms. All the same, when Russell Sage expresses his opinion upon any subject, there is so much sound commonsense in what he says, that the reason for his business success is not difficult to understand. Some time ago he wrote an article for the *Saturday Evening Post*, on "The Gospel of Thrift," that is well worth the attention of every young man. We quote the following:

"Thrift is so essential to happiness in this world, that the failure to practice it, is, to me, incomprehensible. It is such an easy, simple thing, and it means so much. It is the foundation of success in business, of contentment in the home, of standing in society. It stimulates industry. I never yet heard of a thrifty man who was lazy. It begets independ-

ence and self-confidence. It makes a man of the individual who practices it.

"I think the greatest fault that characterizes our education of the young today is the failure to teach thrift in the schools. From the very outset a child ought to understand the value of saving. In some schools, I understand, penny savings funds are now established. Out of these funds, if they are administered with practical common-sense, will grow more sound teaching than out of anything else in the curriculum. I mean teaching that will make for success; and that, after all, is what the mother hopes for for her child, and a nation for its citizens.

"This is a tremendously practical world, and that man is going to get the most out of it who is not hampered by a constant want of money. It is absurd to suppose that great riches always bring happiness, or even that the accumulation of great riches is essential to success. The man of moderate means is, on the whole, perhaps happier than the extremely rich man; and he who makes for himself a safe place in any field, can be set down as being quite as successful as the man who accumulates millions. But the man who is perpetually hard up cannot under any circumstances be happy, no matter what the foolish in the world may say; and no man can win a safe place in the world if he is hampered with debts. Helpless poverty is the most crushing affliction that can come to a family, and is the affliction most easily avoided. The man who starts out right will never be poor in the extreme sense, no matter how limited his income or how circumscribed his opportunities.

"Every young man who wishes to succeed should study carefully the human race. There is even more instruction in the people who are about us than in the books that lie on shelves. All we want is the faculty to read the people as we read the books. And this faculty may, with patience and perseverance, be cultivated.

"Few things so well equip a man for competition with his fellows, as a thorough knowledge of human nature. It will teach him that men are not bad, but weak. He need but avoid their weaknesses to avoid their failures. Not that a negative character is desirable. But as matters stand, even such a character is almost sufficient to insure a reasonable degree of success. But to make this success certain, a positive character is necessary. The young man must not only avoid the vice and weakness of his neighbors, but he must practice the virtues that they do not possess or do not give evidence of possessing."

Dinner-Pail Philosophy

¶ The pessimist always bites the spots on the apple first.

¶ The man who tries to cash flattery always finds it a forgery.

¶ It is hard to be popular with pigs and to keep out of the trough.

¶ Where the feathers of vanity fly there is always a good mark for the gun, but never enough bird to pay for the shot.

¶ You don't need to be a philosopher to draw deductions and learn lessons from the misfortune that befalls others.

¶ No man is so rich that he can afford to lose a friend.

¶ The Master never dwells in the same heart with malice.

¶ Keep things moving. Even a quarrel will die if not stirred up.

¶ If you make hay while the sun shines, very little grass will grow under your feet.

¶ The Lord would be pleased if a lot of people would take the padlocks off their purses and put them on their lips.

INDUSTRY AND COMMERCE

Prevention of Grain Smut

In former years, grain smut constituted a serious menace to the agriculture of North Dakota and of the Northwest in general. The disease is due to a fungus parasite which attacks wheat, oats, barley, rye, etc. Prof. H. L. Bolley, the State Agriculturist, after various experiments, introduced what is known as the formaldehyde treatment, which has proven a specific remedy and is worth millions of dollars annually to the farmers of North Dakota alone. The treatment consists simply in soaking the seed in a solution of formaldehyde just prior to planting. It has now become a general practice, entirely preventing smut.

From Fireman to Engineer

The New York Central and Lake Shore roads have inaugurated a plan which may solve the problem of educating firemen to be competent engineers. Under the new plan, both roads will have examining boards. The New York Central's has already been organized, and will have its headquarters in Albany. The Lake Shore's will probably have its headquarters in Chicago.

The methods of the board are these: In the first year of his service, a fireman gets a book of rules, which pertain wholly to the mechanical and fuel phases of a locomotive. At the end of a year he is examined in the subjects contained in the book, and if he fails is dropped from the service altogether. A similar course is pursued the second year. At the end of the third year, he must attain an average of 80 per cent in the three years' course. Before he gets a diploma as a qualified engineer, however, he must attain 100 per cent in the subjects prepared by the examining board.

Moving a Bank

Out on the Western prairie, the people frequently move from one town to another, taking along not only their household goods but even their houses and stores. The accompanying photograph is that of a bank which was moved a distance of fifteen miles through a portion of South Dakota. As will be

Moving a Bank across the South Dakota Prairies.

noted, the building is a two-story structure of fair size. The lower floor contains the bank proper with its safe, also the private office of the firm. The second story is devoted to storing merchandise. The bankers decided that it would be advisable to locate in another community, as a railroad had been built to it and the business prospects at the new point were better. So the building was lifted from its foundation by jack-screws worked by hand, placed on wooden

trucks provided with wooden wheels, and thus turned into a huge vehicle. Then teams of horses—twenty in all—were hitched to each side and to the front, and the moving across the country was accomplished without accident. Nothing was taken from the building to lighten the load, and it was ready for business on reaching its new location.

American Machinery in India

It is interesting to note that one of The Technical World subscribers, George M. Wise, of the Bengal Iron & Steel Company, Kulti, British India, has recently installed some American machinery in a new steel plant at that place. There are extensive installations yet to be made, comprising conveyors, hoisting appliances, blowers, etc., opening up an inviting field in which the enterprising American will have an immediate opportunity to demonstrate his power to meet the competition of his British or other European rival. Firms manufacturing machinery of the kind mentioned will find it to their advantage to send their catalogues to Mr. Wise.

Pure Food Legislation

At its last session, the North Dakota Legislature passed a Pure Food Law, and the State Food Commissioner says that, whereas one year ago 72 per cent of all the prepared food products in the State were adulterated, now less than 20 per cent are adulterated, while all the most harmful have been driven out.

Making Paper from Wood

Making paper from wood, a method discovered by Dr. J. B. Hill of Augusta, Me., has, in a few years, risen to one of the most important industries of the country. It has revolutionized the paper trade of the world and made it possible for newspapers to be sold at their present low prices.

An old hornet's nest led to this most valuable discovery of Doctor Hill. His friend and neighbor, the late James G. Blaine, had told him that there were not enough cotton and rags in the world to supply the newspapers and other publications with their raw material. That was about twenty-eight years ago when paper was 30 cents a pound. One-half the newspapers of the country must have gone to the wall but for the idea suggested to Doctor Hill by the hornet's nest. He took the nest to the superintendent of a paper factory, who was his friend.

"There, why can't you make paper like that?" he asked.

They sat down together; took the nest apart; analyzed it carefully; and, while it appeared complicated to them, they decided that if a hornet could make paper out of wood, man could do the same. The Doctor discovered that the hornet first chewed the wood into a fine pulp before making it into nest material. The question was, How did the hornet get the fiber? That has not exactly been solved to this day.

Such was the beginning of the wood-pulp industry. Now the logs of wood are floated down the river to a pulp mill. In a surprisingly short time the logs are converted into great sheets of pulp ready to be made into paper.

England's Cotton Famine Over

Once more the clatter of the cotton mills in Lancashire is heard through the full working week. Mills that were closed have opened again, and the great cotton crisis that worked such havoc across the seas has passed. It was the severest England has known since the American Civil War. Speculation of the "cotton kings" in the United States is held largely responsible for the disastrous panic through which Lancashire has just passed. To this was added the calamities resulting from great strikes in Europe and America, and a slight shortage of the cotton crop in America, on which England at present is mainly dependent.

As a result of the disaster, England has taken steps to make herself independent of America as a source of cotton supply. President Macara of the Lan-

cashire Cotton-Growing Association, newly organized, is at the head of the movement which proposes to make the British colonies grow cotton in sufficient abundance to supply Lancashire, whose mills supply the world. It is proposed to begin at once the cultivation of vast cotton crops in West Africa and the Soudan; and, by the agreement, the Lancashire manufacturers must accept cotton from these points in preference to American-grown cotton. This is England's scheme of retaliation for the awful calamity heaped on the English people through the action of American speculators in "futures" and through England's dependence on the American cotton supply.

If this plan succeeds—and its success is very probable, for the wealth of England is backing the movement with British Government sympathy—it is incumbent on America to lose no time in beginning the manufacture of cotton on a mammoth scale so that American growers can find a home market for their raw product. Otherwise supreme disaster threatens the American cotton-growing industry.

It will be a difficult task for Americans to make themselves independent of Lancashire; but once it is done, there is likely to be a great decline in the cotton industry in England, and America may have a Lancashire of her own. Manchester, in Lancashire, is the present center of the world's cotton industry. The cotton is grown in America, shipped to Liverpool, there sold in bale to Manchester, at Manchester manufactured into cloth, and there sold to America again in this form. But it is also sold to other nations, for all the world is learning to wear cotton goods.

Not only in Manchester, but in all the surrounding towns of Lancashire, is the manufacture of cotton goods the dominant industry. This is also the greatest industry of all England; and it is interesting to note that this—one of England's chief sources of revenue—is dependent to a very great extent upon the Southern States of America.

THE WINDING FRAMES INSIDE A LANCASHIRE COTTON MILL.

With the resumption of activity in weaving, the Manchester Cotton Exchange is beginning to display the life of its former days. This exchange stands in the heart of the city, and its members number 2,000. They swarm on the floor and overflow into the adjoining streets.

There are fifty large towns within twenty miles of Manchester where weaving is the sole source of livelihood. There

are Oldham, a town the size of New Orleans; Bolton, as large as Washington, with mills in nearly every street; Ashton-under-Lyne, Heywood, Middleton, Cas-

Inside a Cotton Mill—"Drawing the Cotton."

tleton, and Rochdale, none of which is smaller than Galveston, and all of which are supported by the weaving industry.

The settlement of the great strike has resulted in a unique agreement between the employers and employed. It is known as the "Brooklands Agreement," the terms of which seem to render future strikes out of the question. The labor leaders have access to the books of the employers; and so the sliding scale of wages that has been arranged, can easily be determined without friction or suspicion.

Women and children as well as men suffered untold hardships from the depression in England alleged to have been brought about by the American speculators. More than half the employees of the cotton mills are women and children dependent on their earnings for their daily bread.

All the mills, by an agreement, worked on short hours during the crisis, and many of them were forced to close altogether. There was great suffering among the poor people as it was; but it would have been many times greater but for the wise step of the manufacturers.

Lancashire manufacturers claim that no climate can rival that of Lancashire for cotton-manufacturing industry, because of Lancashire's humidity. Visitors to Lancashire feel depressed when day after day they see the rain descending in

Outside a Cotton Mill—Dinner Time.

unabated persistence; but the native bears the downpour with cheerful equanimity, because he knows that the humidity of the climate renders Lancashire unrivaled in the manufacture of the finer grades of cotton goods. Besides, the workmen of Lancashire are probably more skilled than those of any other country.

The manufacture of textile machinery is also a great industry in Lancashire; and where Lancashire is unable to sell her cotton goods, she does the next best thing, and sells the machinery by which these goods can be produced. Thus she levies a profit even on her rivals.

Hindrances to Cross-Country Auto Tours

Test Trip of 2,000 Miles Shows Prejudice, Bad Laws, and Bad Roads to Be the Greatest Drawbacks in America

WHAT are the principal hindrances to the enjoyment of a cross-country automobile tour taken purely as a pleasure pursuit under existing conditions in America?

To answer this question, so pertinent at this time, when Americans are vying with the French and English and Germans in long overland trips — amusements that have become exceedingly popular in Europe—and when entirely new types of automobiles have been constructed to meet the new demands, Mr. J. F. Miller of the American School of Correspondence at Armour Institute of Technology, made a 2,000-mile trip from Chicago to Syracuse, N. Y., and return, taking careful notations and gathering information from various sources along the route. That the answer might not be formed from conditions as viewed by masculine eyes alone, Mr. Miller took with him a lady companion—his wife—and their joint opinions on the subject will doubtless be interesting to America's growing army of women automobile enthusiasts, as well as to the men.

After a two months' outing and observations made in nearly all kinds of weather, on roads good and bad, and among the varied classes of people that are necessarily encountered in the heterogeneous population of the East and Central West, Mr. and Mrs. Miller have given their answer to the important question. Following is a summary of the objectionable conditions mentioned by them, arranged in order of their importance:

FIRST—The animosity of the rural and urban populace toward automobiles and automobilists, resulting from vituperative newspaper comments, which are ever taken seriously by the countryman.

SECOND—The unjust, partial, and prejudicial laws of many States, counties, and towns, attributable solely to the ignorance of the lawmakers regarding the automobile, its perfect control, and its great benefits to the people in general.

THIRD—Bad roads and bridges, and poor laws that prevent the building and maintenance of better ones.

FOURTH—Difficulties, in sparsely settled districts, of obtaining supplies, and the inferior grades of those that are obtainable.

FIFTH—Parsimony of automobile agents, repair men, and supply houses, manifested in their charging exorbitant prices to automobilists on tour.

SIXTH—Ignorance of rural residents regarding automobiles and the persons who operate them, caused by the scarcity of automobiles owned by persons outside of the cities.

SEVENTH—Improper provision for long trips by the tourist in not selecting a car best adapted to his needs, and in not providing the necessary supplies and provisions before starting.

Threats of being shot; their way blocked; many times impeded by obstructions wilfully placed in their road; insulted and uncivilly treated in innumerable instances — these were occurrences of the trip that go to prove an unfriendliness toward the automobilist on the part of the traditionally kind-hearted farmer. Of course this treatment was rather the exception than the rule; but it was the tourist's mission to note the principal hindrances to the enjoyment of a cross-country automobile tour, and, therefore, he must give prominence to the hindrances. They were encountered, too, without seeking them in any way, but in the course of an ordinary cross-country trip such as any owner of a motor car might take purely for pleasure.

There have been many "endurance" runs that have truthfully tested the endurance of man and vehicle; there have been short- and long distance speed runs, "continuous" runs of thousands of miles, mountain climbing, rough road contests, and every other kind of automobile test that minds could devise, save the simple one of determining, for the information of others, just what conditions are apt to be encountered in an ordinary long-distance pleasure tour. With this object solely in view, Mr. Miller did not try to drive his automobile through raging

torrents or over trembling trestles spanning them; nor did he attempt to scale mountain peaks, or leap from precipices, or bear down trees in his path by forcing his way through the jungles, as do the heroes of the modern automobile tours. He sought to experience no more difficulties than would be unavoidably encountered, and, if possible, to determine why such trips cannot be made as enjoyable and popular in America as they are in Europe.

The machine Mr. Miller regarded as best adapted to his usage on such a trip was a Rambler—the largest make of Rambler—a 16-horse-power two-cylinder car, with canopy top, glass front, and side curtains. Such a machine, Mr. Miller thought, would give him the greatest amount of pleasure and comfort on the trip, and, as stated, it was pleasure and comfort he was seeking. Both of the tourists found the car all they had expected. The jolting, under general conditions, was scarcely perceptible; and the car was roomy, substantial, and easily operated. When the movable glass front and side curtains were all up, the occupants were as secure against the storm as if riding in a Pullman parlor car.

In their tour, Mr. and Mrs. Miller had an opportunity of experiencing the conditions in Illinois, Indiana, Ohio, Pennsylvania, and New York. They found those of New York and Illinois the worst, as regards the unfriendly laws, bad roads, and uncivil treatment. Just as they were entering New York State, the automobilists accidentally turned into a side road. There they encountered a farmer with a shotgun who told them that if they did not immediately turn round and go back he would shoot, as they were traversing a private thoroughfare. The tourists obeyed.

In Illinois the automobile was stoned by hoodlums near the Indiana state line, and a missile fell in the machine at Mrs. Miller's feet. Along a seldom traveled road in Pennsylvania, where automobiles are rarely if ever seen, but where farmers have provided themselves with a private telephone line, news of the tourists' progress was telephoned ahead, and some farmer youths further on placed a mound of obstructions in the road, in the hope of halting the machine, possibly for the purpose of inspecting it more closely. Mr. Miller climbed over the obstructions with his machine, and from the underbrush a dozen heads bobbed up in bewilderment. The couple stopped for lunch at a farm house beyond. While they were dining, another hill of timbers and trees was thrown across the road, which forced the occupants to alight while Mr. Miller cleared the way. In passing through small towns, vile epithets were often hurled at the travelers when they chanced to pass drivers of horses, without recognition of the care manifested by Mr. Miller to prevent scaring the animals.

Mrs. Miller said:

"In many sections we traversed, the people seemed to look upon us as some horrid monsters whom all should hate. We could not get a civil response to our questions, and in one district in Pennsylvania the people began to sound the alarm of our coming as if the territory had been invaded by a real dragon or by outlaws. They gathered about the car, intercepted our progress by various methods, and really for a time we considered ourselves in peril.

"One particular instance well illustrates the horror with which the people seem to regard motor cars. It was in the benighted district between Bryan and Kendleville. The road was a narrow turnpike that would not permit a team and automobile to pass without danger of frightening the horses, especially in this section where an automobile was probably never seen before. Two women driving a span of horses approached us, and the horses showed fright. Fearing for the women's safety, Mr. Miller stopped the car, but still the horses displayed nervousness and acted as if they would become unmanageable. Then Mr. Miller turned off the power entirely and went to the assistance of the women, offering to lead the horses past the machine. The girls shrieked in horror when he started to touch the animals, and would not permit him to lay hands on the harness."

In New York State there is a sparsely settled, low, marshy district whose inhabitants are called "Swamp Angels." The "swamp" part of the term is very appropriate, according to Mr. Miller's statements, but he could not say so much for the "angels."

"While traversing a road in this territory," said Mr. Miller, "we came upon a man and woman driving in the same direction. The road was not wide enough for us to go by them on either side, without probably striking the vehicle or horse, unless they would drive to one side and stop. This they absolutely refused to do, and the horse moped

along in front of us with the occupants all the while jeering at us. 'You have got plenty of time,' the man remarked when we asked him to let us pass. 'Don't be in too big a hurry; it might injure your health,' and the woman laughed until she almost fell from the buggy.

"Well, we endured this derision for probably two miles, barely being able to glide along behind the moping horse. Finally, as neither pleading nor threats seemed of avail, and as the hour was getting late and we were anxious to get out of the swamps before dark, we saw that something had to be done. So I opened up the 'pet' cocks on the engine, and they responded with a vengeance, sounding like the firing of musketry. The horse at once took to his heels and displayed greater life, probably, than his owner had ever noted in him before. On down the marsh-bordered road the man and woman and horse and buggy went, and we directly behind them. The jests of the couple now changed to piteous pleas; but we replied that it was better to hurry a little as they were probably needed at home, and we urged them to go faster. Soon they turned into a cross-road, thinking to escape us; but the car with its 'pet' cock booming away went in behind them, and we followed them for two miles more, and until the horse was nearly exhausted. Then I gave the man a little lecture on how to be polite to automobilists in the future, and I don't think he will forget it.

"This might have seemed imprudent and malicious, but we were taunted and tried beyond forbearance, and were forced to resort to this or some other effective alternative.

"We met with much kinder treatment in other cases, however. As a notable exception, I might mention an instance when we stopped to avoid frightening a team of two splendid looking colts that had been left standing in the harness. We waited for the owner to come and move them away. For this kindness he was profuse in his thanks. He invited us to dinner, and said that he would not have had the colts get frightened for a fortune."

Mr. Miller attributes the greater part of the unfriendly disposition of the people encountered, to the newspapers, but a large amount of it to the politicians. A judge's advice to shoot automobilists has gained wide circulation in many sections of the country traversed; and from this and other such inflammable printed and oral utterances, the pliable-minded ruralist has come to regard the automobilist as something inhuman or an outlaw. In some places along the route he was told that the farmers had organized to hunt with shotguns for automobilists.

WHERE THE ROADWAY IS IDEAL.

The next most serious hindrance enumerated by Mr. and Mrs. Miller is the unjust laws. They are as freakish as they are varied, and outside of Missouri, those of Illinois and New York probably lead the United States in point of capriciousness. In Illinois the speed limit

is 15 miles an hour unless otherwise provided by local ordinance. Drivers must come to a full stop on request of persons driving horses. The maximum fine is $200 or three months imprisonment, or both. The provisions of local ordinances always require a lower speed, and they are such as to form a network of the queerest complications to be found in any

Rambler, with Canopy Top Attached.

civilized land. The law is such that every municipal corporation in the State may have a separate law requiring different numbers on the automobiles, and each charging an additional sum for the fee. Each may, and in most instances does, require a different rate of speed, so that the automobilists must have the most remarkable brain in the world to remember the different speeds permitted by the various towns and hamlets, and to run his machine accordingly so as to avoid being arrested. In the city of Chicago alone there are at least three separate and distinct municipal corporations having jurisdictions over the thoroughfares through which motor cars must pass. They include the City Government, the South Park Board, and the North Park Board. The City controls all the streets except the parks and boulevards; while the park boards have jurisdiction over all the parks and boulevards, and are at liberty, under the laws of Illinois, to make separate requirements regarding numbering and speed. Because an automobilist sometimes gets in the way of Mayor Harrison when he is out bicycle riding, that dignitary has begun a most vigorous campaign against the cars, adding to their persecution in the Western metropolis. The Mayor said:

"I go out on my wheel two or three nights a week, and jog along at eight or ten miles an hour. The automobiles go by me so fast I seem to be standing still. I'll bet there isn't one of them that doesn't run from ten to fifteen miles an hour. One automobile that passed me on Sheridan road was running at the rate of fifty miles an hour. I intend to compel the owners of automobiles to obey the law, if it takes every policeman in Chicago to do it."

So unjust are the Chicago automobile laws regarded that a judge of that city has granted an injunction restraining their enforcement. The automobilists in their bill charged "grave oppression of the people," "double taxation," "discrimination," "arbitrary legislation," and "disfigurement of machines." The law limits the speed limit of the city to ten miles an hour; requires numbers five inches high; charges a fee of $3 for a license, and an additional fee of $1 for the registration of the number allotted. Some of the suburbs around Chicago, when they need money to build a new sidewalk, stretch a rope across a thoroughfare, and arrest every automobilist that passes through, regardless of the speed he is making, fining each an amount necessary to make up the required sum. Of nine machines that passed through one of these suburbs recently, all but one were stopped and the operators fined, and that one escaped only because he got out and walked with his machine as proof indisputable that he was not violating the speed ordinance.

These are some of the conditions that caused Mr. Miller in telling of his trip, to say:

"I was glad when I was out of the city limits of Chicago in beginning my trip, and glad again when I had reached the State line and was free from the oppressive Illinois laws.

"In Indiana, there is no State automobile law, but all the towns through which we passed had local ordinances regulating speed. Valparaiso, for instance, limits speed to eight miles an hour. Lafayette taxes automobiles, and requires owners to register and number them.

"Somewhat similar conditions prevail in Ohio. Through that State our journey was the most peaceable and enjoyable of any on our tour, and I must congratulate the people of the State for their sanity, and lack of bombast. Were it not for the bad condition of the roads in portions of Ohio, that would be an ideal State for motoring.

"In Pennsylvania, the rate of speed is limited to one mile in three minutes in the country districts, and eight miles an hour in the cities. A license must be procured from the treasurer of one of the cities or counties, and the license number must be conspicuously displayed on the back of the vehicle. Two lighted lamps must be carried from one hour after sunset to one hour after sunrise. Brakes and a bell or other signal must be carried. The laws of this State are regarded by automobilists as very objectionable, especially as they pertain to cities. At Lancaster an automobile club has been formed with the object of securing State legislation giving automobilists the same privileges on the public roads as other travelers. The various turnpike companies of the State are now levying excessive tolls. Pittsburg has an automobile club with over 200 members, and in that city there are more than 600 owners of automobiles. They have done good work in securing fair legislation, but are hampered considerably by the State law.

"The New York State laws are nearly like those of Illinois, but not quite so erratic. A speed of 20 miles an hour is permitted in the open country; 10 to 15 miles in cities, except at crossings; and in crossing bridges, dams, sharp curves, or steep descents, the speed must be reduced to four miles an hour. The law requires numbers three inches high and each stroke ½ inch wide. Registration certificates are issued by the Secretary of State, and the charge is $2 for new certificates.

"Of course when a tourist is anxious to make any speed of consequence he is put to considerable inconvenience in a transcontinental trip by bumping into the different laws of the various States and counties and towns. In most of the States that have laws, the chauffeur is required to come to a stop when any person driving a team holds up his hand. This would be a good law, probably, but for the mean advantage many persons take of it. Often a bumpkin will hold up his hand, require the car to stop, and then laugh as if he had performed a remarkably funny joke.

"Mr. Sidney S. Gorham of the Chicago Automobile Club declares—and I agree with him—that to stop an automobile in front of a frightened horse, is the very worst thing that could be done. The object that frightened him is still there in full view when the car is stopped; and as long as it is there the horse is going to continue frightened, and his fright is apt to increase. A test will demonstrate to any one that it is better for the automobile to speed on by the horse, and get out of the way as soon as possible. Then and only then will the horse become composed.

"As to the roads it may be said that there are no good ones in America. This country scarcely knows the meaning of the word. That is an important reason as to why cross-country touring cannot be expected for a long time to attain the prominence here it has in Europe. Probably the best roads encountered on the trip were between Elkhart, Ind., and Wauseon, O. They are in many places unusual, being turnpiked, so that the center of the road is considerably higher than the sides. They are smoothly graded, and covered with a coating of fine red gravel, making them almost equal to our city boulevards. The trip through the good roads country of Ohio and Indiana was exceedingly enjoyable; the kaleidoscopic nature of the scenery, with its woods, farmlands, crystal streams, and occasional villages alternately bursting into view, and the civil treatment of the inhabitants, all combined to add to the attractiveness. From Cleveland to Buffalo the route was along the shores of Lake Erie, and each mile seemed to compete with the former in showing something more beautiful.

"Everywhere I found the automobile owners and automobile clubs actively engaged in move-

No Obstructions Here.

ments for good roads. Did they but have the friendship and co-operation of the farmers and general public instead of their blind animosity, good roads and good streets would soon be universal in our country. At Columbus, O., the Automobile Club, a very influential body, recently passed resolutions condemning the city officers for the deplorable condition of the streets. This condition, which is a great menace to automobilists, is due to the action of the street car companies and gas companies in cutting deep trenches in the streets and failing to refill them properly. The Columbus Automobile Club contends in its resolutions that the city ordinance calling upon corporations to deposit from $10,000 to $20,000 with the City Government at the time of granting the franchise—which sum is to be kept for the purpose of meeting claims for street repairs that the city may make against the corporations—is not complied with.

"In Illinois, most of Indiana, a small part of Ohio, and in New York, the roads are bad; but the prospects are that automobiles will work a speedy improvement. Between Utica and Syracuse and between Utica and Albany, the roads are in wretched condition.

"A small stretch of good road in Onondaga county, New York, has just been completed, and shows what is possible all over the country. A half mile addition in this county forms a road 2½ miles long, of almost perfect macadam, and has aroused great enthusiasm among the residents of Syracuse, as this is their first and only good road."

Mr. Miller says that the greatest actual accomplishment of the good roads movement has been the work of the State aid plan which has been adopted in ten States. The plan creates a State Highway Commission, and provides for the co-operation of the State with the counties and towns in the work of road improvement, each bearing a fixed part of the expense. While no two States have adopted exactly the same plan, the fundamental principles of all are the same and the objects are the same. The plan has been adopted by all the northeastern States from Maine to Pennsylvania and Maryland, and the results have been so satisfactory that it has attracted attention all over the country. Pennsylvania's last legislature appropriated $6,500,000 as a State fund to be expended during six years, the State paying two-thirds the cost of the road built. In New York the State pays one-half the cost, and the last legislature made an appropriation of $600,000 for this purpose. In Connecticut the State pays two-thirds of the expenses, and the annual appropriations are $225,000. Massachusetts spends nearly half a million dollars a year, the Commonwealth paying three-fourths of the cost. In all the States where the plan is in vogue, the sentiment for national aid is very strong. It is argued that the only ideally perfect and just system of co-operation is one in which the Federal Government shall enter as an active factor.

"The bicycle did a little toward promoting good roads," said Mr. Miller, "but the results of its work are infinitesimal compared to what the automobile is accomplishing. Therefore, why should not the automobile be the friend of the agriculturist rather than an object of his hate? As cross-country trips increase with the increased number of good roads, why cannot the ruralist's horse become accustomed to the motor car as readily as does the city horse? Vague superstitions regarding the automobile, which they know not, and the vituperative newspaper comments, abetted by exaggerations and fakes, have caused the ruralist to regard the automobile as a death-dealing monster and its occupants as outlaws and murderers. Nothing could be more ridiculous than such a sentiment, yet it prevails in every State I traversed.

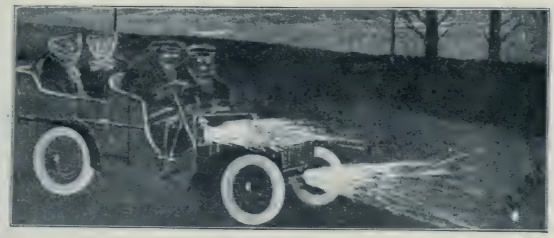
"These things seem to demonstrate that what is most greatly needed to aid the automobilist in enjoying the rights and liberties an ordinary citizen should be allowed, is a campaign of education to remove from the minds of the people the erroneous ideas with which they now are filled. I should advise automobile owners and automobile clubs to begin a movement to acquaint legislators with the automobile. Let them take members of the State legislatures, county and town boards, and city councils on rides in up-to-date automobiles; demonstrate to them the perfect control with which the machine can be handled; show them the innumerable advantages it offers to both the city and country; that how, instead of being a Juggernaut car, it is a boon to humanity and should be encouraged. The farmer, the automobile's greatest enemy at present, will be the very person who is to receive the greatest benefits from its growing popularity, for it will improve his roads and ultimately improve his means of locomotion, as the farmer himself will soon be riding in automobiles and sending his products to market in them. In the city the automobile will add vastly to the sanitary conditions; do away with the filth and unsightliness of the streets caused by horse traffic, as the time will come when a horse will no more be permitted on the principal streets of a modern city than is an ox or a cow. The horse superseded the ox as a beast of burden because of its superior cleanliness and speed; the automobile will likewise supersede the horse because of its superior cleanliness and speed. Therefore, take the alderman or other legislator in your automobile and ride him about the country. Ride him at the rate of eight miles an hour, and he will condemn the automobile; ride him at fifteen miles an hour, and he will like it; twenty-five miles an hour, and he will want to go again; at forty miles an hour, and he will buy an automobile.

"These are our joint convictions resulting from the observations of our trip. The study we made was interesting; but I feel that the work was only half accomplished. I learned what the conditions are in half of the continent, but not what they are in the other half. I intend to make another trip, the next time going from Chicago to San Francisco, noting as carefully all the conditions I encounter. My trip was enjoyable, notwithstanding the numerous hindrances."

"The weather was fine," said Mrs. Miller, "with the exception of a terrific hail storm which we encountered after leaving Westville. Hail stones pelted down on the machine at a terrific rate for nearly an hour. The ground all about was white as winter until the hail had melted. We closed the curtains, however,

and with the glass front and canopy top we kept as dry as if we had been in our home; and our progress was not hindered. After that, we came to a valley farther on where the water had caused a little creek to overflow to many times its regular width. Mr. Miller pulled off his shoes, and waded into it to discover whether it was a creek or a river, and being convinced, we ran the car through without any trouble, although the water reached to the hub of the wheels. During the entire trip we experienced not a single break or accident to the machine."

Mr. Miller relates many experiences of exorbitant prices charged for supplies *en route*. Prices for storing over night were as high as $5 for a single night. Therefore he appreciated the unusual courtesies he met with at the hands of Mr. T. C. Whitcomb of Cleveland, O., whose place has become exceedingly popular because of his disposition not to "bleed" strangers as do most of the other dealers. The tourists emphasize the importance of straining gasoline through chamois skin or some other water-tight substance. They say there is nothing so hard to locate when the motor runs unsatisfactorily as water or other foreign substances in the gasoline. On one occasion when Mr. Miller stopped at a small town for a supply of gasoline, the merchant was very indignant when asked that it be strained. He was surprised when half a teacup of water and sediment was taken out of five gallons of gasoline. Mr. Miller also states that it is a good plan to strain the oil, especially that used in the feed cup, as it insures an even supply and prevents clogging, which often permits the piston to run dry.



Lay Excursions in Science

First Paper

By CHARLES PIERCE BURTON
Author of "The Bashful Man and Others"

PERMIT ME to make the profound remark that we live in a queer world and a wonderfully interesting one, in this era of scientific and industrial development. However the present period of human history may rank in literature and art, we certainly are living in a scientific and strenuous age. This observation may not be especially original; the fact has doubtless been noticed before by some of the world's great thinkers. But it is true, and truth possesses advantages even over originality.

Mankind is making tremendous strides forward in practical working knowledge of the material universe: it bothers a layman to keep up with the procession. The "Arabian Nights," with its genii, its wizards, its Aladdin's Lamp and Old Man of the Sea, is not a circumstance to the actual events of the present day,

which, did we not see them with our own eyes, would be beyond belief. We dwell in fairyland; and life is worth living, if for no other reason than to watch the development of society through scientific discovery and its application to industry.

What strange, self-contained creatures we are! The marvels that science discloses from day to day are taken as matters of course. People live unheeding in the presence of Niagara. Who voluntarily takes off his hat when a railroad train thunders by? We notice the electric light only to grumble if it goes out. We talk through miles of space, and growl at the telephone girl if there is a half minute's delay. With no feeling save mild curiosity, we hear whole operas emerging from some tiny machine seemingly not large enough to contain the scale.

As recently as two hundred years ago, our superstitious ancestors hanged many people supposed to be guilty of witchcraft and to be able to ride through the air on broomsticks. To-day, if we matter-of-fact people should happen to see some modern wizard sailing the circumambient atmosphere astride a stick, we should look on with some interest perhaps, but straightway endeavor to improve the stick and the mode of riding.

I wish to express my appreciation of these tireless men of science. They may scare us to death, but we shall never die of *ennui*. One feels reconciled to the stupendous scheme of the universe and even to Adam's fall. What if man had been created with perfect knowledge and Nature had unfolded all of her secrets to him at the start? How stupid it would be! Now the omnipotent and omnipresent newspaper places on our breakfast tables each morning some startling scientific theory or discovery, and life takes on new meaning.

A few decades ago, science set us all agog over the missing link; then, that perplexing conundrum electricity absorbed public attention. And man has been wandering around ever since in a bewildering maze of electric undulations, airships, microbes, liquid air, and higher criticism. I am living in constant anxiety lest, to-morrow, science will demonstrate that the entire physical universe is but the varying expression of electrical energy. Someone will be sure to corner that; and where shall we be then, I should like to know.

We no sooner became somewhat accustomed to the idea of liquid air than it passed out of mind, and radium proceeded to upset our theories. The more I read about radium, the less I know about it. I shouldn't know radium if I should meet it in the back yard. In effect it seems to be liquid sunshine, and entirely beyond a layman's comprehension. Liquid air, on the contrary, appeals to the imagination; we can in a measure grasp the idea.

There is something extremely delightful in the thought of liquid air, especially to those of us who half believe that air exists only in the imagination, until some storm forces the truth upon us. How seemingly impalpable is air! We move through it at will. We look out and cannot see it. We reach out our hand and cannot take hold of it. It evades the senses. Often only by its absence, so to speak, can we detect its presence. Yet, when aroused, no human monument can withstand it. And here is mere man, wizard though he be, who actually freezes it to a temperature of 312 degrees below zero and squeezes it into a liquid. For all we know to the contrary, he will some day reduce the temperature several hundred degrees more, squeeze a little harder, and store up great chunks of winter weather for the comfort of suffering humanity during July and August. A few cubes of frozen atmosphere five hundred degrees below zero would not be bad things to turn loose during dog days.

After all, the imagination stands appalled before the possibilities in these discoveries, liquid air and liquid sunshine, which may be destined to supersede steam and electricity, make a high standard of living inexpensive, and so solve in a great degree the social problems of the age. What a time will that be, when the industrial world can be run by wind power, which until now has been reserved for farmers and orators; when the smoke nuisance shall have been abated, and one can go down town with clean linen on his manly bosom and not have it covered with soot before return-

ing! With infinite wonder and pity will posterity read of the smoke nuisance.

Liquid air! Radium! How strange a story! Perhaps here at last is solved the problem of aërial navigation; and, if only the atmosphere extended to Mars, we might hope to cross through space and pay the people of that far-off planet a social visit. But alas! balloons and airships cannot travel beyond the atmosphere, and we are prisoners. Fifty miles above, could we not anchor at the surface of this great air ocean, and experiment with ether? If only we could see the billows rage and toss in those mighty convulsions we call storms!

Liquid air! It reminds one of liquid music. Why not? Let some military band blow one of Sousa's great marches into the freezing machine. It is a warm tune, but great is science. Then, while the air is still heaving and quivering in the throes of harmony, squeeze it. A strong machine ought to stand the pressure. The march properly compressed ought, perhaps, to fill an ordinary wine glass with a most curious liquid which would emit a musical vapor and play for us while we dine. Possibly a whole comic opera, jokes and all, could be held in a quart dipper.

How wonderful is science which invades even the arts! A prophetic vision is upon me, of the seventh son of a seventh son, born with two veils. I see music carted along the street like water, with signs reading, "Annie Rooney, five cents a barrel!" "Choice Wagnerian Operas, pint bottles, three dollars a case!" "Opus Forty-five, One Dollar," "A few quarts of 'Hiawatha' and 'Bedelia', left over from last year's stock, will be given away. First come, first served."

How Did You?

Did you tackle that trouble which came your way
With a resolute heart and cheerful,
Or hide your face from the light of day
With a craven soul and fearful?
Oh, a trouble is a ton, or a trouble is an ounce,
Or a trouble is what you make it!
And it isn't the fact that you're hurt that counts,
But only—how did you take it?

You are beaten to earth? Well, well, what's that?
Come up with a smiling face.
It's nothing against you to fall down flat,
But to lie there—that's disgrace.
The harder you're thrown—why, the higher you bounce;
Be proud of your blackened eye!
It isn't the fact that you're licked that counts;
It's how did you fight—and why?

And though you be done to the death—what then?
If you battled the best you could,
If you played your part in the world of men—
Why, the Master will call it good.
Death comes with a crawl, or comes with a pounce;
And whether he's slow or spry,
It isn't the fact that you're dead that counts,
But only—how did you die?

In order to receive attention, all inquiries must be addressed to the Consulting Department, and must be accompanied with the *full name and address of the sender*. In view of the fact that the inquiries already received have far exceeded the available space, the Editors reserve the right to select for publication only those inquiries likely to be of greatest interest to the readers of the magazine in general. Other inquiries will be answered by letter.

C. G. S. System—Units of Force and Work

Question: Explain the "C. G. S." system used in Mechanics. Also the units of force and work, and give their English values.—*J. C. V.*

Answer: The units of mass, length, and time are said to be "fundamental" units, since all other units, such as those of area, velocity, acceleration, power, etc., are referred to them. These latter units are therefore called "derived" units. The magnitudes of the fundamental units are, however, arbitrary. A large class of writers use the centimeter, gramme, and second, and this system is usually called the "C. G. S." system; others use the foot, pound, and second. It thus becomes important to have a systematic method of reducing measurements from one system of units to another.

For strictly scientific purposes, a unit of work is taken to be the work done by a unit of force when its point of application moves through one foot in the direction of its action; but, as a convenient and sufficiently accurate standard for practical purposes, the quantity of work which is done in lifting 1 pound through the height of 1 foot is commonly adopted as the unit, and this quantity of work is spoken of as one *foot-pound*. It is, however, important to observe that the foot-pound is not perfectly invariable, since the weight of a pound, and therefore the work done in lifting it through a given height, differs at different places, being a little greater near the Poles than near the Equator.

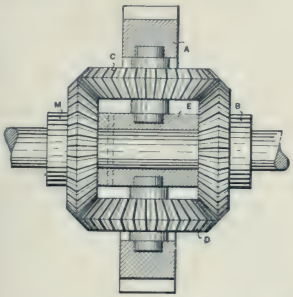
On the metrical system, the *kilogrammeter* is the unit; it is the work done when the weight of one kilogramme is raised through a height of one meter. This is equal to 7.24 foot-pounds, and one foot-pound = .1381 of a kilogrammeter.

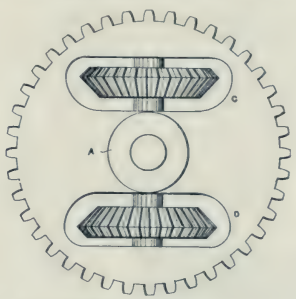
The unit of force is the *poundal*. The poundal may be defined as the force necessary to produce an acceleration or gain of velocity of one foot per second, when it acts on a mass of one pound for one second. In the "C. G. S." system, it is called the *dyne*, and represents a gain of velocity of 1 centimeter per second when it acts on a mass of 1 gramme for one second. In one system the units are given as so many foot-pounds, and in the other so many gramme-seconds.

How to Find a Positive or Negative Terminal

Question: Please explain if there is any way of finding the positive or negative terminal of a generator if we know the direction of motion, the machine being at rest.—*H. G. A.*

Answer: This can be determined by Fleming's rule, which states that if we hold the thumb, first finger, and second finger of the right hand, all three at right angles, and the thumb represents the direction of motion, the first finger the direction of lines of force, then the second finger will represent the direction of current flow. By testing with a compass you can determine which is the north pole of your machine, and knowing that the lines of force pass from the north pole to the south pole through the air, this will give you their direction. Then apply the rule given you, and you can obtain the direction of current flow. The terminal toward which the current flows will be the positive.





COMPENSATING GEAR FOR AUTOMOBILE AXLES.

Differential Gear

Question: What is the construction and method of working of the differential gear such as is used on the rear axle of an automobile?—*N. P. W.*

Answer: The accompanying figure shows a form of compensating gear which, with various modifications of detail, has received a very extensive application. The axle is divided at the center, and, riding on the two abutting ends, is the hub E of the gear or sprocket A. This hub rides loosely upon the axle; and in the body of the gear are the two freely moving bevel pinions C and D. To the two ends of the shafts, the bevel gears B and M are respectively keyed. It is evident that under ordinary conditions on a straight line, the two bevel gears B and M will be rotated with their shafts in the same direction and at the same speed as the gear A. But when passing a curve, it is quite possible for either of these gears to turn more slowly than the other and thus permit the desired compensation in the movement of the wheels.

How to Clean a Boiler

Question: What is the best method of cleaning a badly scaled boiler, and what compound should be used?—*A. C. P.*

Answer: First open boiler up, and note where the loose scale, if any, has lodged. Wash out thoroughly, and put in the required amount of compound. While the boiler is in service, open the blow-off valve for a few seconds, two or three times a day, to be assured that it does not become stopped up with scale.

After running the boiler for a week, shut it down; and, when the pressure is down and the boiler cooled off, run the water out and take off the hand-hole plates. Note what effect the compound has had on the scale, and where the disengaged scale has lodged. Wash out thoroughly, and use judgment as to whether it is advisable to use a less or greater quantity of compound, or to add a small quantity daily.

Continue the washing out at short intervals, as many boilers have been burned by large quantities of scale dropping on the crown sheets and not being removed.

It is necessary to have a chemical analysis of the water used in order fully to

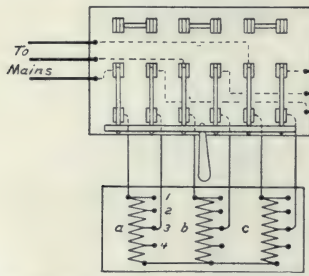
determine the kind and quantity of compound to be used. An alkaline compound that has given satisfaction, consists of water, 58 per cent soda-ash, and 70 per cent caustic soda. Proportions, 3,750 gallons of water, 1,600 pounds of soda-ash, and 2,600 pounds of caustic soda. This has been used where the principal incrusting solids have been calcium carbonate and sulphate and magnesium sulphate.

Reversing Rotation and Current Connections of Compensator

Question 1: How do you reverse the direction of rotation of a revolving three-phase synchronous motor?

Question 2: If you reverse the direction of the current in the fields, will that have any effect on the motor?

Question 3: Beginning at the right and lettering the three armature leads A, B, C, if you leave A connected as it was but transpose the wires running to B and C, what will be the effect?



Connections of Compensator with 3-Phase Motor.

Question 4: Is a compensator a transformer or a reactance coil?

Question 5: Please describe the necessary connections and switches for connecting up a compensator with a three-phase motor.—*F. J. M.*

Answer 1: The direction of rotation can be reversed by interchanging any two of the leads.

Answer 2: This will have no effect on the motor.

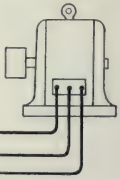
Answer 3: Transposing wires B and C will reverse the direction of rotation.

Answer 4: A compensator is an autotransformer, or a transformer with only one coil; or again, it may be considered a reactance coil.

Answer 5: The accompanying sketch shows connections required for a compensator with a three-phase motor. The compensator consists of coils *a, b,* and *c,* wound on a laminated iron core, each coil being provided with a number of taps, 1, 2, 3, 4, etc. When starting the switch is in the lower position, as shown; and when the motor has reached its rated speed, the switch is thrown to the upper or running position, so that the primary terminals are connected directly to the line.

Storage Batteries

Question 1: Why are there more negative plates than positive plates in a storage battery? Is it absolutely necessary?



Question 2: What is found on the positive and negative plates of a storage battery when it is charged? And what occurs when the cell is discharged?

Question 3: How is the capacity of a storage battery usually expressed?—*A. P. O.*

Answer 1: There are more negative plates than positive in a storage battery, so that each positive plate may have a negative plate on both sides of it. This is perhaps not absolutely necessary, but very desirable.

Answer 2: When a cell is charged, $Pb\ O_2$ is found on the positive plate and Pb on the negative plate. When the cell is discharged $Pb\ S\ O_4$ is found on both plates.

Answer 3: The capacity of a storage battery is usually expressed in ampere-hours.

Overturning of Derricks

Question: Will you please tell me why a derrick or derrick car will lift and hold a weight the capacity of the same, if weight is higher than the bottom of the boom of the derrick, but if lowered below that point the car will tilt or the derrick will upset?—*C. H. P.*

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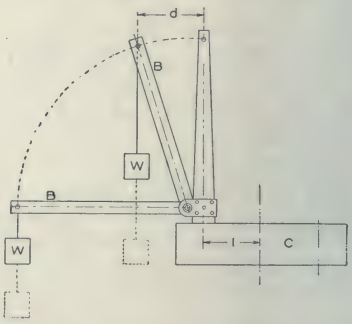
CONSULTING DEPARTMENT—(Continued)

Answer: We think that you must refer to different positions of the boom rather than to different heights of the load, for it is a fact that the height of the load in no way affects the tendency of the derrick to overturn. Referring to the figure, you will see that the load is shown in two places in full lines, and in two places in dotted lines. For any one position of the boom, the turning moment is constant for a given load. In



the first case, where the boom is shown nearly vertical, the tendency to turn about the center line of the mast would be W*d*; and, supposing the derrick car C to be supported on the line passing through the center of the mast, the tendency to overturn about this support would be expressed by the moment W*d*. The tendency of the car to resist this overturning, is expressed by its weight multiplied by the distance L, which represents the distance of the center of gravity from the center line of support under consideration. If the weight W is such that when the boom is nearly vertical the car just balances the weight, then, when the boom is swung to the horizontal position shown, the car will overturn. Since the moment now is W×B, in which B represents the distance from the end of the boom to the center line of the mast, the tendency to turn in the horizontal position is as much greater than that in the nearly vertical position, as the distance B is to D.

For formulas relating to derricks, see THE TECHNICAL WORLD, Vol. 1, No. 4 (June, 1904), page 474.

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CONSULTING DEPARTMENT—(Continued)

Fly Wheel for Gasoline Engine

Question 1: I have designed an 8-H. P. gasoline engine. I want to know what sized fly wheel I should use on this engine, the same being a 6x6 and to run at 800 R. P. M. What diameter, width of face, and thickness of same, the fly wheel to be a 5-spoke style?

Question 2: What will be the approximate weight of wheel?

Question 3: How do you calculate the H. P. of a gasoline engine, size 6-inch bore, 6-inch stroke, and 800 R. P. M.?

Question 4: How do you calculate the size and weight of a fly wheel, the H. P. of engine given?—*C. S.*

Answer 1: From the data which you have given, the diameter of the fly wheel should be 28 inches, width of face 8 inches, and thickness 2 inches.

Answer 2: The weight should be about 350 pounds.

Answer 3: Having given the dimensions of the cylinder and the speed, the only other variable quantity is the working fluid. With gasoline, the average M. E. P. is assumed to be 60 pounds. Applying these values to the formula:

$$\text{I. H. P.} = \frac{\text{A} \times \text{M. E. P.} \times \text{S}}{33{,}000},$$

we have:

$$\text{I. H. P.} = \frac{28 \times 60 \times 200}{33{,}000} = 10.2 \text{ H. P.}$$

In the above formula, A is the area of the piston in square inches; and S is obtained by multiplying the stroke in feet by one-half the number of revolutions per minute.

Answer 4: The diameters and weights of fly wheels vary to a considerable extent, among engines turned out by different builders. The exact weights depend upon the character of the work done by the engine. For pumping and machine work, the effort need not be as constant as for electric lighting and other fine work. To determine the weight, the diameter of the wheel must be known, or the ratio of the diameter of the wheel to the length of the stroke. In any case, the maximum linear velocity should not be greater than 6,000 feet per minute. Taking this maximum, we have (since the engine is to run at 800 R. P. M.):

$$6{,}000 = 3.1416 \times \text{diameter} \times 800.$$

From this formula, the diameter is found to be 2.4 feet.

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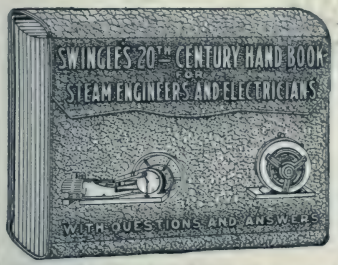

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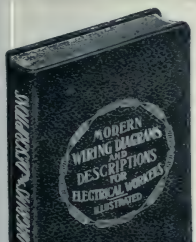

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$$W = \frac{C \times d^2 \times b}{D^2 \times N^2},$$

in which C is a constant that varies for different conditions (for ordinary work it is about 700,000); d is the diameter of the cylinder in inches; b is the length of stroke in inches; D is the diameter of fly wheel in feet; N is the number of revolutions per minute; and W is the weight of the rim in pounds.

Knowing the diameter of the fly wheel, the width of the face and thickness can be determined, since the weight is considered as being in the rim. If b equals the width of the face in inches, t the thickness of rim in inches, and d the diameter of fly wheel in inches, we then have:

W (total weight) = .2607 (weight of 1 cubic inch of cast iron) $\times b \times t \times \pi \; d = b \times t \; .819 \; d.$

Either the breadth or the thickness must be assumed, and then the other dimension determined from the formula.

Grove Gas Battery

Question: Please describe the Grove Gas Battery. What voltage will a single cell of this battery produce?—*G. M. D.*

Answer: In the battery that bears his name, Grove immersed two platinum plates covered with films of different gases in a dilute solution of sulphuric acid. Between the platinized platinum plates charged with different gases and a platinum electrode saturated with hydrogen, he obtained the following E. M. F.'s:

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Bromine	0.56	Carbon dioxide	0.42
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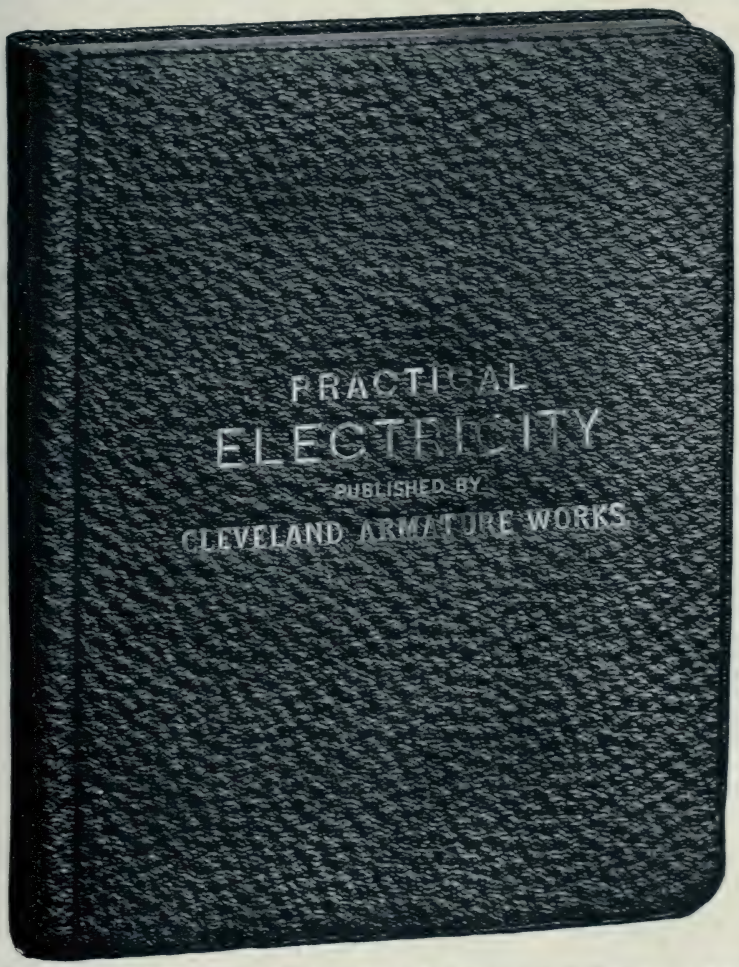

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CONSULTING DEPARTMENT—(Continued)

Star vs. Delta Connection

Question: Please explain the advantage of the Star connection over the Delta connection in the three-phase generator for long-distance transmission.—*A.*

Answer: In the case of the Star connection, the voltage between the mains is $\sqrt{3}$ times as great as that over the coils, while the current in each main is the same as that in the corresponding coil.

In the case of the Delta connection, the voltage between the mains is the same as that over the coils, while the current is $\sqrt{3}$ times as great in the mains as in the coils. On this account, the Star connection is more suitable for long-distance transmission than the Delta.

Horse-Power of Triple-Expansion Engine

Question: Please let me know through THE TECHNICAL WORLD, the formula for figuring the H. P. of a triple-expansion engine by condensing the M. E. P. of the cylinders to the low pressure; sizes of cylinders, 28 inches, 48 inches, and 72 inches; stroke, 42 inches; vacuum, 26 inches; piston travel, 200 feet per minute; boiler pressure by gauge, 160 pounds. —*W. J. O.*

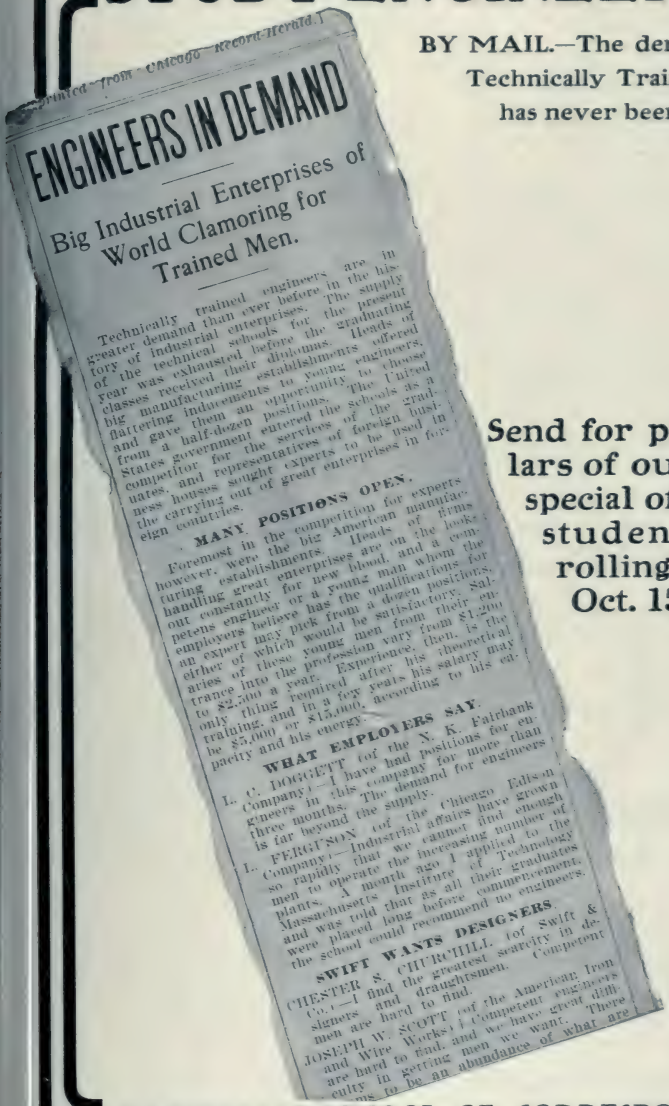
Answer: In reducing all the pressures to the area of the low-pressure cylinder, the same general formula as for a simple engine can be used; that is:

$$\text{H. P.} = \frac{\text{P} \times \text{L} \times \text{A} \times \text{N}}{33{,}000},$$

in which P is the sum of the total M. E. P.'s referred to the low-pressure cylinder; L, the length of stroke in feet; A, the area of the low-pressure cylinder in square inches; and N, the number of strokes per minute. To reduce the M. E. P. of each cylinder to the corresponding pressure on the low cylinder, you must multiply the M. E. P. of the cylinder under consideration by the ratio of its volume to the volume of the low-pressure cylinder. If, as is usually the case, the stroke is the same in all cylinders, then the ratio of the volumes will be the same as the ratio of the squares of the diameters. For instance, the ratio of the intermediate to the low-pressure cylinder is:

$$\frac{48^2}{72^2} = \frac{4}{9}.$$

STUDY ENGINEERING



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Foremost in the competition for experts, however, were the big American manufacturing establishments. Heads of firms handling great enterprises are on the look-out constantly for a young man whom the captens engineer or a new blood and a keen employers believe has the qualifications for an expert may pick from a dozen positions, either of which would be satisfactory. Salaries of those young men from $1,200 to $2,500 a year. Experience, from $1,200 to $2,500 a year. Experience, from $1,200 only thing required after his salary may be training, and in a few years his theoretical capacity and his energy.

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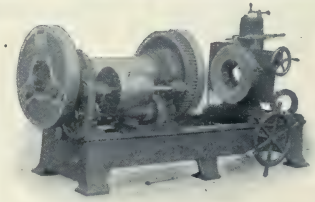

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Multiplying the M. E. P. of the intermediate cylinder by 4/9, we would have the pressure referred to the low cylinder.

Similarly, the pressure on the high can be determined; and if we add the M. E. P. of the high and intermediate (referred to the low) to the M. E. P. of the low itself, we have the total M. E. P., or the value of P in the formula. Of course the M. E. P. mentioned above cannot be determined accurately without the aid of the indicator diagram.

If the piston speed in feet per minute is given, then the terms L and N in the formula can be omitted, and the piston speed substituted.

Cement for Leather

Question: Give formula for quick-setting cement for leather belts, that oil will not affect.—*A. W. N.*

Answer: Take 16 parts gutta-percha, 4 India rubber, 2 pitch, 1 shellac, 2 linseed oil. Cut small, melt together, and mix well.

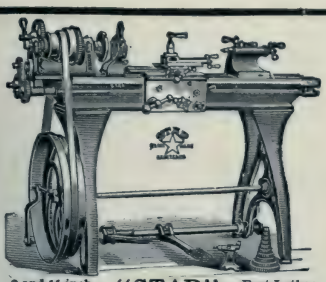
Resistance of Ground

Question: Please give me formula for the resistance of a ground by the voltmeter method.—*F. W. W.*

Answer: This can be found by using a Weston voltmeter as follows: Connect one side of the circuit to one binding-post of the voltmeter, and connect a water pipe to the other binding-post of the voltmeter. If now there is any deflection, we know that there is a ground on the opposite side of the circuit from that to which the voltmeter is connected. The resistance of this ground may be found by the formula:

$$R = r\left(\frac{V}{v} - 1\right),$$

in which R equals the resistance of the ground leak required; r equals the resistance of the voltmeter; V equals voltage between the positive and negative sides of the line; and v equals the reading of the instrument.



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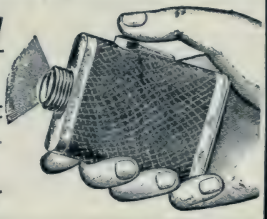

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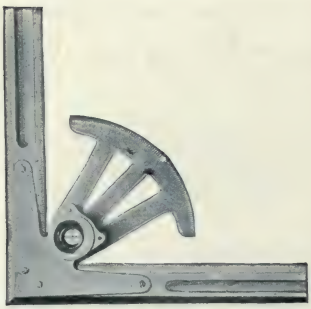

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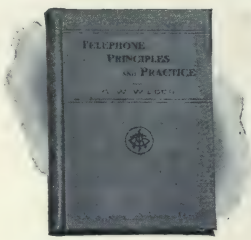

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PERSONAL AND MISCELLANEOUS

A Well-Deserved Honor

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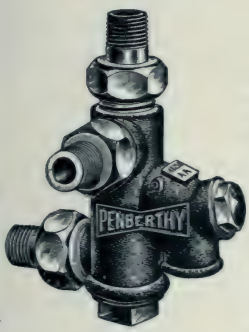
Electricity in India

THIS GREAT ENERGY, which is the leading feature of the day in nearly all parts of the world, but chiefly in America, has of late years been making gradual progress in the greatest of British possessions in the East.

Commencing from the south, it may be interesting to note how the Government of Mysore has endeavored to improve her state by the use of electricity derived from power from the natural waterfalls of the Cauvery. Gold mining by this great unknown power has already proved a success, and various large extensions and improvements under leading British and American firms are in progress.

The Presidencies of Madras and Bombay, though somewhat late in the field, have at present schemes for the improvement of their capitals; and even the great

ABOVE ALL OTHERS



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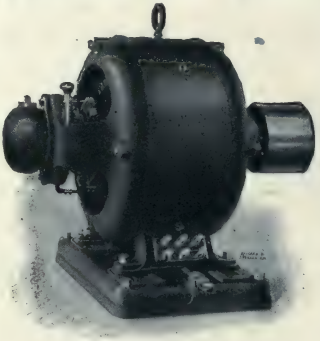

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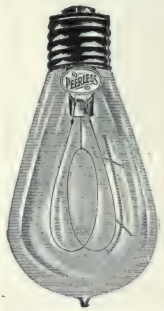

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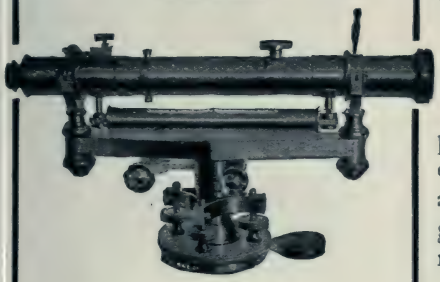

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T. SAIGA.

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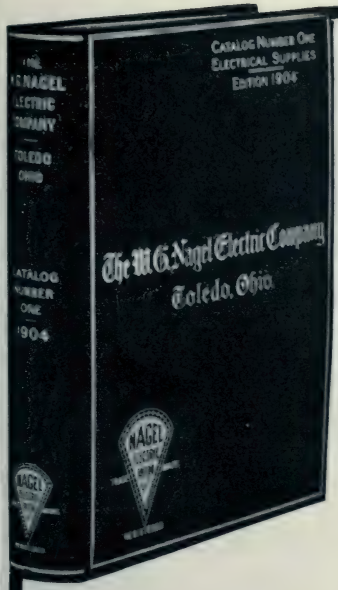

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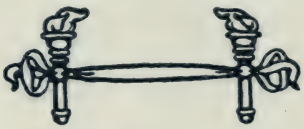

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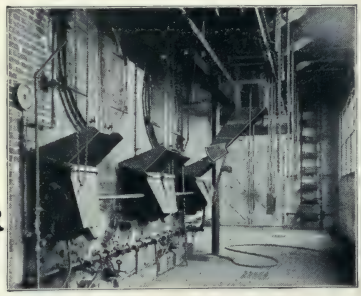

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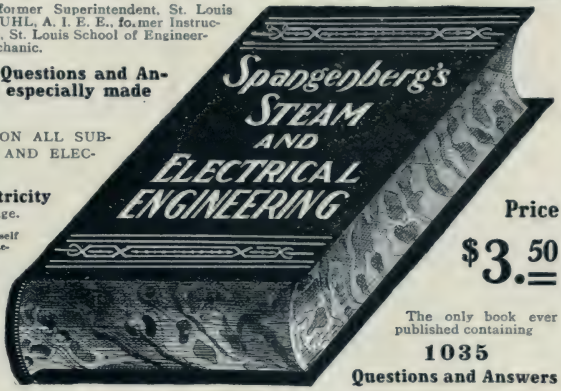

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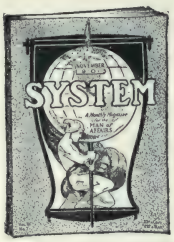

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The Englishman arose, and in the tone of a Briton bold said: "Here's to Great Britain, the sun that gives light to the nations of the earth!"

The Frenchman was rather taken back at this, but he proposed: "Here's to France, the moon whose magic rays move the tides of the world!"

Franklin then rose, and with an air of quaint modesty said: "Here's to George Washington, the Joshua of America, who commanded the sun and moon to stand still—and they stood still!"

Each in His Degree

He carried the chain to the farmer's fence.
Cried the farmer's wife: "Now get you hence!"
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Books Received

Modern Practical Electricity. By R. Mullineux Walmesley. Volume IV. Pages 318. Published by W. T. Keener & Company, Chicago, Ill. Price, $3.00 per volume.

THIS IS VOLUME IV of the work reviewed in the May issue of this magazine. The inductor alternator is discussed, with the application of the turbine for driving of the same, together with armature windings for two-phase and three-phase machines. The theory of alternator armature reaction, characteristic curves, and excitation, is taken up briefly. The connection of generators in parallel, both direct- and alternating-current, is treated in Chapter 3, the subject including paralleling of alternators, of course, involving that of synchronizing.

Chapter 4 is devoted to continuous current motors of various types and makes. The latter part of the book is devoted to electrical testing and the different forms of galvanometers, meters, and measuring instruments.

Stair Building Made Easy. By Fred T. Hodgson. Pages 160. Cloth. The Industrial Publication Company, New York. Price, $1.00.

AS THE AUTHOR SAYS in the preface, most books on this subject are too expensive for the young workman, and are defective in that they are too advanced. The purpose of this book is to avoid both these objections by furnishing information from the beginning, and at a price within the means of the poorest apprentice.

The terms used in the branch of joinery are first explained. The simplest forms of stairs are considered first, so that the reader may advance step by step. The numerous diagrams show just how to place the strings, treads, and risers. Winding stairs are fully explained, as this form is more difficult of construction than the straight form.

Some excellent designs of newels are shown, as are also full-page illustrations of staircases.

Constructive Drawing. A Textbook for Home Instruction, High Schools, Manual Training Schools, Technical Schools, and Universities. Arranged by Herman Hanstein, Supervisor of Drawing in the Chicago High Schools. Second Edition, Revised. Cloth. Pages 72. Plates. Published by Keuffel & Esser Company, Chicago, New York, St. Louis, and San Francisco. Price, $1.00.

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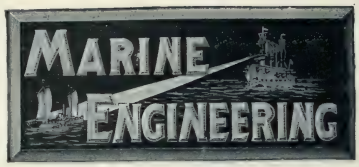

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of plane geometry in technical drawing. Not many authors of textbooks in drafting have given this fundamental branch of architectural and mechanical drawing so thorough a treatment as in "Detailing" is often required. With its convenient arrangement and its concise, plain language of the text, opposite each construction, this book undoubtedly will win the favor of teachers and students.

Forge Practice. By John Lord Bacon. Published by John Wiley & Sons, New York. Pages 257. Illustrated. Cloth. Price, $1.50.

EVERY STUDENT taking forging, whether in a manual training school or college, should have this little book. Instructors in shop practice will find in it much valuable matter. It is written in a simple style, and contains the matter one would expect to find in a book bearing such a title. The fact that it has 273 illustrations shows how well its features are presented graphically. These cuts are practically all sketches showing positions of tools and the pieces being forged. The chapters on Welding and Calculation of Stock are especially good. Other chapters are: Simple Forged Work, Steam Hammer Work, Duplicate Work, Metallurgy of Iron and Steel, Tool-Steel Work, Tool Forging and Tempering, Miscellaneous Work.

Friction and Lubrication. A Handbook for Engineers, Mechanics, Superintendents, and Managers, by William M Davis. Cloth. Illustrated. Indexed. 8vo. Pages 250. Published by the Lubrication Publishing Company, Pittsburg, Pa. Price, $2.00.

A PRACTICAL BOOK by a practical man. Almost all books dealing with the various kinds of machinery have a few pages on lubrication; but here are 250 pages just on this subject. The book treats of the theory of friction, various lubricants themselves, and the methods of applying the lubricants. The author "begins at the beginning," starts with the reasons why lubricants are necessary, by a concise discussion on friction and frictional losses.

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MACHINERY EXHIBIT AT ST. LOUIS.—A RATIONAL BASIS FOR WAGES.—CHAS. C. CHRISTENSEN, M.E.—THE HERSTAL NATIONAL ARMORY.—MOLDING MACHINES.—THE ALTIMETER.—A TRAVELING MACHINE SHOP.—FORMING TWIST DRILLS.—PHOTO TAKEN BY RADIUM.—GERMAN HIGH-SPEED LOCOMOTIVE.—IRON AND STEE PROSPECTS IN FRANCE.—MACHINE FOR SPLITTING WOOD.—NEW FLOATING DOCK IN GERMANY.—COST OF STEAM VS. HORSE POWER.—REFRIGERATING MACH'Y IN BATTLESHIPS.—POWERFUL TOYS OF WEALTHY AMERICANS.—WASTED MACHINERY ON PANAMA CANAL.—ELECTRIC POWER ERA IN SCOTLAND.—PNEUMATIC MAIL TUBE TESTS IN CHICAGO.—THE PAY CHECK SYSTEM.—STORY TOLD AT WORLD'S FAIR.—NEW MACHINERY OF THE MONTH.—HINTS IN MECHANICAL ENGINEERING.—QUESTIONS AND ANSWERS.

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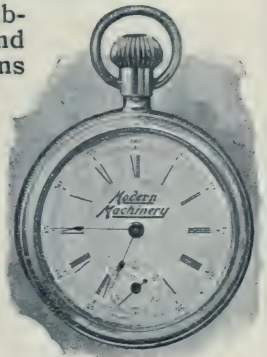

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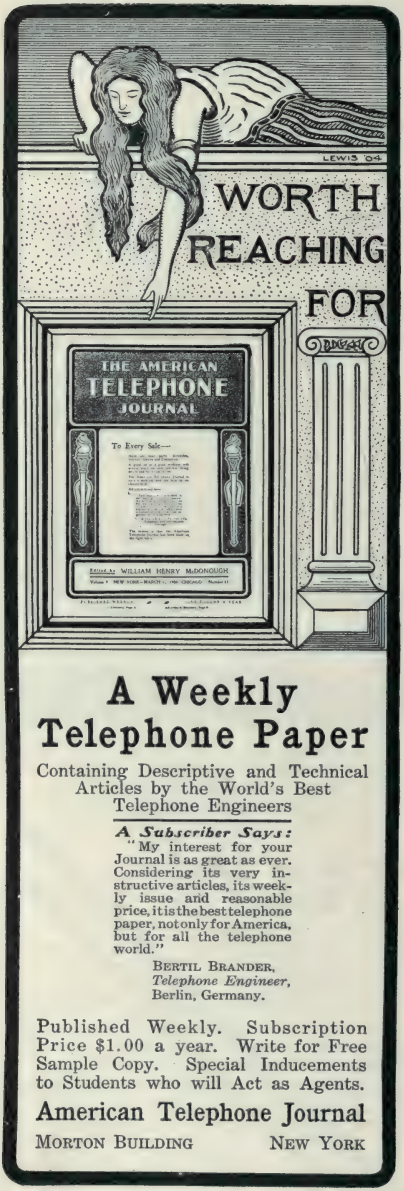

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LITERATURE—(Continued)

ing a chemical analysis with simple instruments, add to the practical value of the work. The dividing up of the book into short chapters adds much to its convenience, as information upon the lubrication of any given class of machinery is readily found. There are chapters on lubricating appliances; lubrication of gas engines, automobiles, and street-railway cars; oiling devices and systems; treatment of hot bearings; lubrication of refrigerating, mining, and textile machinery, etc.

This is by far the best book we have ever seen on this subject, and one that is worth far more than the price asked for it.

Magazines

Cassier's Magazine (September)—New York

"MATHEMATICS IN ENGINEERING" is the title of a discussion on the value and use of pure mathematics in engineering. The writer, Mr. Thorburn Reid, says mathematicians unconsciously grow to think of the solution of a problem, not as a means to an end, but as the end itself. He advances the idea that mathematics would be more valuable if properly taught. The fact that few teachers are practical engineers is responsible for the prevailing defects. As the teacher seldom, if ever, has an opportunity to check his results by practical application, he naturally gives problems of little practical value, and his methods of analysis are either defective or absolutely wrong.

Many incidents are cited, showing the value of practical knowledge, some proving that a shrewd estimate is often as reliable as extended calculation.

"Vacuum-Tube Lighting," by D. McFarlan Moore, describes the new form of illumination based upon a gaseous electrical conductor for the source of light. The article sets forth the advantages of the vacuum tube over the arc light, the main points being its diffusion and closer imitation of daylight. The illustrations show rooms lighted by this method, and diagrams indicate relative locations of parts.

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Some of the Writers.

PROF. F. B. CROCKER, head of Department of Electrical Engineering, **Columbia University**: author of the sections on Storage Batteries and Management of Dynamo Electric Machinery.

PROF. WILLIAM ESTY, head of the Department of Electrical Engineering, **Lehigh University**: author of the section on Alternating Current Machinery.

H. C. CUSHING, Jr., Wiring Expert and Consulting Engineer: author of the section on Wiring for Light and Power.

PROF. DUGALD C. JACKSON, Collaborator with **PROF. GEORGE C. SHAAD**, University of Wisconsin: author of sections on Power Transmission, Electric Lighting and Central Stations.

J. R. CRAVATH, Western Editor of the **Street Railway Journal**: author of the section on Street Railways.

PROF. LOUIS DERR, **Mass. Institute of Technology**: **WILLIAM BOYRER**, Telephone Expert and Consulting Engineer; **CHAS. THOM**, Chief of Quadruplex Department Western Union Telegraph Co.: author of section on Telegraphy, and others.

Partial Table of Contents.

Part I.—Static and Dynamic Electricity—Primary Batteries—Ohm's Law—Wire Calculations—Electrical Measurements—Wiring for Light and Power—Electric Telegraph, including the Duplex and Quadruplex.

Part II.—Theory of Dynamo-Electric Machinery—Design and Construction of Dynamos and Motors—Types of Machines—Storage Batteries, including Theory, Management and Types.

Part III.—Incandescent and Arc Lighting—Electric Railways, including Car Wiring, Line Construction, Third-Rail and Multiple-Unit Systems—Management of Dynamo-Electric Machinery—Power Station Work, including Boilers, Engines and Electrical Machinery—High Tension Transmission.

Part IV.—Theory of Alternating Currents—Construction, Types and Operation of Alternators, Transformers, Induction Motors, Synchronous Motors and Rotary Converters.

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LITERATURE—(Continued)

Other articles are:

Transporter Bridges, by Benj. H. Ridgely, M. T. Hugues. Thornwall Haynes.

Changes in Machine Tool Design, by C. H. Benjamin.

The Most Powerful Locomotive in the World, by Geo. W. Martin.

Variable Speed Appliances, by E. K. Hood.

Industrial Locomotives, Part III, by J. F. Gairns.

Drop-Valve Engines, by Charles Hurst.

American Electrician (September)—New York

ONE OF THE MOST INTERESTING ARTICLES in this issue is upon the repulsion motor, in which the author treats this piece of apparatus as a transformer with secondary coil movable with respect to the primary. The author has attempted to treat the subject in a manner simple enough to be easily comprehended without the use of the complex mathematical symbols which are so often confusing to the average reader.

Under the heading "A Progressive Western Telephone Exchange," H. K. Sprague discusses the new telephone exchange at Boulder, Col., recently completed by the Colorado Telephone Company. The company has outgrown its former quarters, and, at the same time that it is moving into its new building, is remodeling its equipment from the old-style magneto system to the common battery central energy.

An interesting discussion of the Electric Power Field by George E. Walsh shows many reasons why the use of electricity for power is becoming more and more popular. Often manufacturing concerns and mills, owing to the difficulty of obtaining fuel, have been obliged to move away from towns and cities where they were suitably located as far as markets and supply of raw material were concerned. With electricity supplied from large central stations, however, at wholesale rates, this difficulty is obviated.

Other articles are:

Feeding Steam Boilers.

Traffic Design of Central Office Switchboards.

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How to Make a High-Voltage Testing Battery.

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LITERATURE—(Continued)

Power (September)—New York

OF THE MORE IMPORTANT ARTICLES, "Gas Producers for Power," by Julius I. Wile, is perhaps the most interesting, especially to one engaged in the generation of power. In this article the chemical end receives due attention. The article describes both the suction and the pressure types and is well illustrated.

"Valves and Valve Gears," by Robert G. Griswold, explains in simple style and excellent diagrams, the action of the plain slide valve.

"Splicing Leather Belts," by W. E. Dixon, M. E., is another valuable contribution on this topic. The methods of using the scraper, opener, and splicing board, are well illustrated.

Among other articles may be mentioned:

The Power House of the Interborough Rapid Transit Company.

Curves of Performance, by W. H. Booth.

Expansion Joints for Smoke Flues, by C. E. Flanigan.

Lubricating Oils, by W. M. Davis.

European Practice in the Use of Superheated Steam, by Franz Koester.

Catalogues

International Steam Pump Company, New York. Pumping Machinery. Pages 16. Paper, 8½ by 12 inches.

A HANDSOME CATALOGUE in which are described and illustrated with excellent half-tones forty types of pumping machinery comprised in the exhibit of this company at the St. Louis Exposition, including not only pumps proper, but also air-compressing and steam-condensing apparatus, cooling towers, vacuum machines, water meters, etc. The processes in which these machines are employed on the Exposition grounds, such as timber preserving and refrigeration, are fully explained, and diagrams and graphical charts are employed to illustrate the design and arrangement of apparatus. A striking view of the Grand Cascade is shown on the cover, and the immense Worthington turbine pumps by which the water is supplied are described. Sent free on application.

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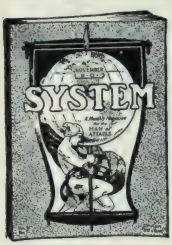

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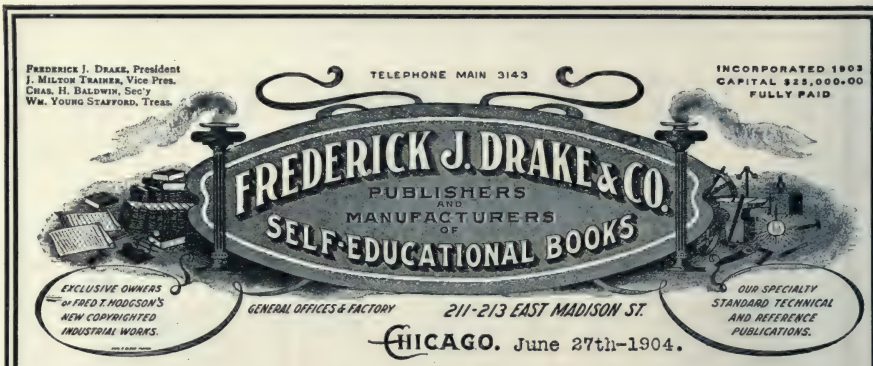
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